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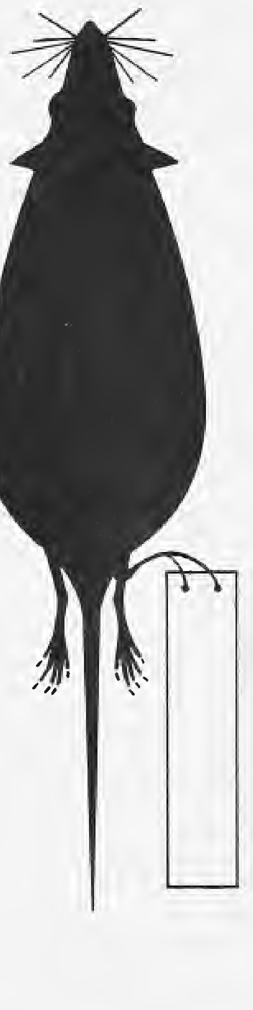

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# A GUIDE TO THE MANAGEMENT OF RECENT MAMMAL COLLECTIONS

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# INTRODUCTION

In North America there are almost 400 Recent mammal collections that collectively store and maintain over two and one-half million specimens (American Society of Mammalogists, 1974; Choate and Genoways, 1975). These collections are continuously growing in size and in number, and are a valuable resource for many disciplines, particularly those fields affiliated with education, systematics, environmental studies, wildlife biology, parasitology, and biomedicine (Genoways *et al.*, 1976). As a result, considerable time, money, and space are often devoted to provision of proper storage, maintenance, and utilization of these collections (Irwin *et al.*, 1973; Conference of Directors of Systematic Collections, 1971).

With the growth and development of Recent mammal collections, numerous ideas concerning collection management have been conceived. Some aspects, such as collecting and preparing specimens, have received considerable attention, and thus have become improved and more or less standardized. Other areas, such as cataloging procedures, collection arrangement, and fumigation, have received no attention, or at best, have been discussed on occasion in some obscure publication. As a result, very little change has occurred in these areas and the techniques utilized may be quite diverse between collections.

This paper represents an effort to compile relevant literature, techniques, and ideas that concern various aspects of North American Recent mammal collections. To prevent a biased presentation, detailed questionnaires dealing with most phases of collection management were sent to several curators of Recent mammal collections. The collections of those that responded to the questionnaire represent a diversity of size, geographic region, place of professional staff training, and institutional affiliations, and include the following: Royal Ontario Museum (ROM), 100 Queens Park, Toronto; National Bird and Mammal Laboratories (USNM), National Museum of Natural History, Washington, D.C.; Museum of Vertebrate Zoology (MVZ), University of California, Berkeley; Museum of Wildlife and Fisheries Biology (WFBM), University of California, Davis; Museum of Natural History (UCONN), University of Connecticut, Storrs; Florida State Museum (FSM), University of Florida, Gainesville; Wildlife Laboratory Collection (PUWL), Purdue University, Lafayette, Indiana; Museum of the High Plains (MHP), Fort Hays Kansas State College, Hays; Museum of Natural History, University of Kansas (KU), Lawrence; Museum of Zoology, University of Michigan (UMMZ), Ann Arbor; James Ford Bell Museum of Natural History (MMNH), University of Minnesota, Minneapolis; Vertebrate Museum (VMKSC), Kearney State College, Kearney, Nebraska; American Museum of Natural History (AMNH), Central Park West at 79th Street, New York; Museum of Natural History (OSMNH), Oregon State University, Corvallis; Carnegie Museum of Natural History (CM), 4400 Forbes Avenue, Pittsburgh; Texas Cooperative Wildlife Collection (TCWC), Texas A & M University, College Station; The Museum (TTU), Texas Tech University, Lubbock; Puget Sound Museum of Natural History (UPS), University of Puget Sound, Tacoma, Washington; Zoological Museum (UWZM), Noland Zoology Building, University of Wisconsin, Madison. From this diversity, it is hoped that most ideas, techniques, and procedures used in a majority of the Recent mammal collections are represented. It is further hoped that this publication will serve as a guide to the management of Recent mammal collections.

The format of this guide generally follows the sequence of the procedures of incorporating specimens into the collection. This sequence basically involves acquisition, processing, storage, maintenance, and utilization (Fig. 1).

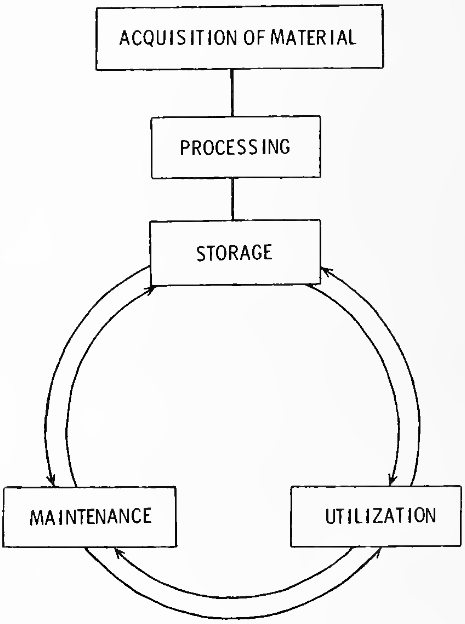



Fig. 1. Generalized flow chart of collection management procedures used in collections of Recent mammals. For additional details see Figs. 2, 8, 35, 36, and 39.

# ACQUISITIONS

## LAWS AND ETHICS

Prior to the acquisition of any material for a Recent mammal collection, it is absolutely necessary to be aware of all laws and regulations relevant to collecting, possessing, transporting, and conducting transactions involving biological specimens (Genoways and Choate, 1976). The most important law in the United States concerning acquisition of such material is the Lacey Act of 1903, which states:

"(a) Any person who—

(1) delivers, carries, transports, or ships, by any means whatever, or causes to be delivered, carried, transported, or shipped for commercial or noncommercial purposes or sells or causes to be sold any wildlife taken, transported or sold in any manner in violation of any Act of Congress or regulation issued thereunder, or

(2) delivers, carries, transports, or ships, by any means whatever, or causes to be delivered, carried, transported, or shipped for commercial or noncommercial purposes or sells or causes to be sold in interstate or foreign commerce any wildlife taken, transported, or sold in any manner in violation of any law or regulation of any State or foreign country; or

(b) Any person who—

(1) sells or causes to be sold any products manufactured, made, or processed from any wildlife taken, transported, or sold in any manner in violation of any Act of Congress or regulation issued thereunder, or

(2) sells or causes to be sold in interstate or foreign commerce any products manufactured, made, or processed from any wildlife taken, transported, or sold in any manner in violation of any law or regulation of a State or a foreign country, or

(3) having purchased or received wildlife imported from any foreign country or shipped, transported, or carried in interstate commerce, makes or causes to be made any false record, account, label, or identification thereof, or

(4) receives, acquires, or purchases for commercial or noncommercial purposes any wildlife — (a) taken, transported, or sold in violation of any law or regulation of any State or foreign country and delivered, carried, transported, or shipped by any means or method in interstate or foreign commerce or (b) taken, transported, or sold in violation of any Act of Congress or regulation issued thereunder, or

(5) imports from Mexico to any State, or exports from any State to Mexico, any game mammal, dead or alive, or part or product thereof, except under permit or other authorization of the Secretary or, in accordance with any regulations prescribed by him, having due regard to the requirements of the Migratory Birds and Game Mammals Treaty with Mexico and the laws of the United States forbidding importation of certain live mammals injurious to agriculture and horticulture;" [shall be in violation of the Lacey Act and shall be subject to the penalties prescribed...(18 U.S.C. 43.)]

Although this law is relatively rigid, it is possible to work within its limitations, providing that proper procedures are followed and appropriate permits are secured. To insure that all requirments are fulfilled for collecting, possessing, and transporting biological specimens, or conducting transactions involving them, it is recommended that the appropriate federal agencies (for example, Department of Agriculture, Department of Commerce, Department of Health, Education, and Welfare, Department of Interior) and state or foreign country governments be contacted for information, laws, and permits (Genoways and Choate, 1976; McGaugh and Genoways, 1976). Because of legal responsibilities as defined by the Lacey Act in acquiring material for the collection, it is strongly recommended that records be maintained to document the legality of all acquisitions. In fact, for situations involving federal permits, maintenance of records is required by the law, which states:

"From the date of issuance of the permit, the permittee shall maintain complete and accurate records of any taking, possession, transportation, sale, purchase, barter, exportation, or importation of wildlife pursuant to such permit. Such records shall be kept current and shall include names and addresses of persons with whom any wildlife has been purchased, sold, bartered, or otherwise transferred, and the date of such transaction, and such other information as may be required or appropriate. Such records, unless otherwise specified, shall be entered in books, legibly written in the English language. Such records shall be retained for 5 years

from the date of issuance of the permit." (CFR 13.46)

In addition to stringent laws, Recent mammal collections are also governed by a code of ethics that emphasizes the maintenance of professional standards. The ethics of an institutional collection depend upon the individual. The standards followed by the individual are the foundation of standards for the institution. It is necessary, therefore, for the individual to adhere to a strict code of ethics by making a conscientious effort to do accurate and thorough work, acting in a responsible and dependable manner, and encouraging others, particularly subordinates, to establish a similar set of standards. Although adherence to ethics begins with the individual, efforts have been made to set guidelines for maintaining professional standards in acquiring and managing Recent mammal collections (American Society of Mammalogists, 1974; Grinnell, 1922; Hairston, 1970). Basically, these guidelines include:

1) Respect for all laws and regulations
2) Having a purpose for collecting specimens
3) Limiting collecting efforts to avoid adverse effects on populations or species
4) Avoiding excessive collecting (beyond the needs of the collecting purpose)
5) Obtaining maximum use and information from all specimens collected
6) Insuring proper care and availability of all specimens collected
7) Promoting accuracy and order in systematics collections
8) Maintaining and improving relations with people associated and concerned with the collecting of biological specimens.

Finally, curators of Recent mammal collections have responsibilities to fulfill before an acquisition is completed. Not only must they maintain legal and ethical standards in dealing with incoming material they must also evaluate the use or scientific value of such material. Material without any practical utilization or scientific value, or that has questionable authenticity, should not be accepted for any reason. The responsibility for accepting incoming material is further influenced by physical limitations. There must be an unbiased awareness of the cost, time, and space required to process and maintain the incoming material (Anderson, 1973). For most collections and acquisitions, this is a minor problem. But when proper care for any particular acquisition cannot be provided, the material should be deposited at a collection where the requirments can be met.

## CONSIDERATIONS PRIOR TO ACQUISITION

Before specimens are obtained by the institution, a basic knowledge and planning of the functions of Recent mammal collections are necessary to promote better management of the collection. For this reason, written procedures for all aspects of the collection should be prepared and made available to everyone associated with the collection. Many procedures have received considerable attention through publication and have become standardized among most Recent mammal collections. For instance, descriptive procedures for scientific preparation of speciments for the collection are common in the literature (Anderson, 1965; De Blase and Martin, 1974; Hall, 1962; Knudsen, 1966; Kung *et al.*, 1970; Setzer, 1963). Although many collection procedures have been published, there are many phases of collection operations that have not been described. Furthermore, individual collections may have unique situations not discussed in the literature (for example, procedures for writing collecting localities). For these reasons, a collection should develop and distribute its own set of information, instructions, and policies, particularly for processes that may be variable or questionable among different collections. Such information will prove useful in standardizing and organizing procedures and training personnel. An example of specific information and instructions that are regularly distributed to those associated with the mammal collection at Texas Tech University includes the following guidelines for documentation.

> The data for each specimen should include sex, reproductive condition, collecting locality, external measurements, date of death, name of preparator, and preparation number. If the collector of the specimen is not the preparator, then the name of the collector should also be included. The format for recording data (with the exception of locality) will follow the style used for mammals by Hall, 1962 (Collecting and Preparing Study Specimens of Vertebrates, Misc. Publ., Univ. Kansas Mus. Nat. Hist., 30:1-46).
>
> All localities in field notes and on specimen tags will be written in a form with the more general locality descriptions preceding the more specific locality descriptions (for example, Texas: Lubbock Co.; Lubbock *or* Nebraska: Dundy Co.; 4 mi N, 2 mi W Parks). The reasons for using this format are

that the style has already been established at Texas Tech University, and that this form expedites data-capture efforts for computerized information retrieval.

For Canada, Mexico, and the United States, the first locality description will be the name of the state or province. For all other countries the first locality description will be the name of the country (for example, Texas: Lubbock Co.; Lubbock *or* Chihuahua: 10.5 km W Cuauhtemoc *or* British Columbia: 12 mi N, 3 mi E Prince George *or* Honduras: 7 km S San Pedro Sula). It is felt that the states of Canada, Mexico, and the United States are familiar enough to justify the omission of the name of the country.

There will be no documentation of localities based on road junctions (with other roads, rivers, railroads, etc.). Such localities are difficult to find, particularly for workers not familiar with the area. In addition, such designations are subject to change, in name or geographical location of roads. Further complications may also occur when a road forms more than one junction with a given feature within a restricted area.

Localities should be taken from specific reference points—towns, cities, or possibly natural features (for example, Guadalupe Peak)—that occur within the same political boundaries used to describe the collecting locality. Specific reference points should be reasonably permanent and should be indicated on most general road maps. If it proves much more desirable to use a specific reference point that occurs within a different political boundary than that of the collecting locality, the following style should be used (for example, Texas: *in* Jeff Davis Co.; 5 mi S Kent). The county listed should be the county where the collecting locality occurs, although the specific reference point (Kent) actually occurs in a different county (Culberson County).

Localities should also be taken with reference to the major compass points (north, south, west, east), with the longitudinal directions (north and south) preceding the latitudinal directions (west and east). It is preferred that no localities be taken with reference to other compass point subdivisions (for example, northwest, southeast, east-northeast, south-southeast) because of the difficulty in pinpointing such localities.

It is urged that all possible methods of pinpointing collecting localities be used. However, if such methods require a more detailed description than established by the instructions above, it is suggested that such locality descriptions be explained in the field notes. For any locality referred to in the field notes, an explanation of its position should be detailed and clear enough so that anyone could return to the exact area.

Such requirements have improved and standardized field data, expedited cataloging procedures, and contributed greatly to the organization of processing and utilizing specimens. Because of these advantages and others, some collections (for example, USNM, AMNH, and UPS) in addition to that of Texas Tech University provide users with detailed instructions and information concerning various aspects of the respective collections.

Another consideration is the importance of accurate and thorough field notes and personal catalogs. Good notes can be as valuable as the specimens. For this reason, it is advisable to encourage proper documentation and to maintain all notes permanently with the collection. Because of assured continuous care, maintenance, and greater utilization, the original notes should be kept with the collection. Under certain circumstances, the author may wish to keep the notes for later personal use. If so, the author should be provided with a duplicate copy.

## SOURCES OF ACQUISITION

The first phase of any Recent mammal collection is the acquisition of material for the collection. Although acquisitions may occur in several ways, or combination of ways, most acquisitions of Recent mammal collections are received from internal sources through efforts of institutional staff or students, or from external sources through exchanges, purchases, gifts, deposition of voucher specimens, or permanent and long term loans (Table 1). The amount of material provided by any source is largely dependent on the size, affiliations, resources, goals, and activeness of the collection.

### INSTITUTIONAL STAFF AND ASSOCIATES

For many Recent mammal collections, a major source of material is actual collecting efforts of the collection staff and associates. Obtaining specimens in this manner can be expensive because of travel, equipment, wages, and other expenditures. However, the material resulting from these efforts is a valuable contribution to the collection, and would therefore justify any necessary expenses. Often, material

TABLE 1. SOURCES[1] OF SPECIMEN ACQUISITION FOR 18 COLLECTIONS OF RECENT MAMMALS.

| | Internal Sources | | External Sources | | | | |
|---|---|---|---|---|---|---|---|
| Institution | Institutional | Students | Exchanges | Purchases | Gifts | Disposition of Voucher Specimens | Other |
| ROM | 2 | — | 3 | 1 | 5 | 4 | — |
| USNM | 1 | — | — | — | 3 | 2 | — |
| WFBM | 1 | — | 2 | 5 | 4 | 3 | — |
| UCONN | 1 | 2 | 5 | 6 | 4 | 3 | 7 |
| FSM | 3 | — | — | — | 1 | 2 | — |
| PUWL | 1 | — | 3 | 5 | 2 | 4 | — |
| MHP | 1 | 3 | 4 | 6 | 5 | 2 | 7 |
| KU | 2 | — | 4 | 5 | 3 | 1 | — |
| UMMZ | 1 | — | 4 | 5 | 3 | 2 | — |
| MMNH | 2 | — | 3 | 5 | 4 | 1 | — |
| VMKSC | 1 | 2 | 3 | 5 | 4 | — | — |
| AMNH | 1 | — | — | — | 3 | 2 | — |
| OSMNH | 3 | 4 | 5 | — | 2 | 1 | — |
| CM | 1 | — | 5 | 3 | 2 | 4 | — |
| TCWC | 1 | — | 4 | 5 | 3 | 2 | — |
| TTU | 1 | 2 | 3 | 4 | 6 | 5 | 7 |
| UPS | 1 | 6 | 4 | 5 | 3 | 2 | 7 |
| UWZM | 1 | 2 | 6 | 7 | 5 | 4 | 3 |

[1]Sources are ranked from 1 to 7 for each institution, 1 being the most important. A blank indicates no specimens received from this source. Museum acronyms are given in Introduction.

collected by the staff and associates is accompanied by a considerable amount of data resulting from independent and cooperative research. Such data are significant additions to the scientific value of the specimen as well as the collection.

## STUDENTS

Another form of acquisition, which is primarily restricted to collections affiliated with educational institutions, results from collecting performed as a part of course requirements, or research performed by advanced students. Although such material would ideally be permissible in any collection, it must be realized that some specimens, particularly those obtained from beginning students, may not meet the standards of the research collection because of the lack of experience in preparation and in taking and recording data. If such material is deposited in the research collection, supervision of collecting and preparation by a responsible and experienced person is needed. Specimens obtained from advanced students, particularly those associated with research, can prove to be a valuable and often a significant source of material for the collection.

## EXCHANGES

Another common means of acquiring material, particularly among smaller collections, is the practice of exchanging specimens. Generally, the specimens exchanged represent locally common species and are traded on a one-to-one basis unless prior arrangements are made (for example, TTU traded 20 specimens of uncommon species to the University of Montana for a skin and skeleton of *Oreamnos*). The primary advantage of this type of acquisition is that new taxa can be added to the collection at a considerably smaller cost than would be required to obtain the same material by other means. The primary expenses incurred are shipping charges and the specimens used in the exchange.

## PURCHASES

Acquisitions resulting from purchases can provide a way of adding specimens of unrepresented taxa or geographical regions. However, such practices are generally discouraged because they tend to promote unscrupulous collecting by individuals that are often more interested in monetary gain, than in the scientific value of the specimens. When purchases are made, every effort should be made to acquire all pertinent information and materials associated with the specimens. Also, because of individual, ethical, and legal responsibilities, care should be taken to purchase only material that has been legally collected, possessed, and sold. By establishing requirements for

field notes, associated materials, and copies of permits, to accompany all specimens purchased, those individuals that obtain specimens to sell to institutions will be compelled to assure the scientific quality of the specimens and to obtain such specimens only by legal methods.

### GIFTS

Acquisitions resulting from gifts can present a dilemma because of the problems involved in accepting or rejecting gifts of questionable scientific value or alternative uses of the material. In the event a gift is accepted, an acquisition contract (see Accessioning) should be received from the donor, and every effort should be made to obtain all possible information and associated materials concerned with the acquisition. In exchange for gifts that are subject to taxation, donors may expect a valuation of the donation for income tax purposes. Because of stipulations established by the Internal Revenue Service, valuations of gifts made by personnel of the recipient institution are generally not acceptable. Such valuations are valid only through transactions made by the donor, Internal Revenue Service, and approved appraisers. For maintaining institutional records for inventory and insurance purposes, the Internal Revenue Service suggests the use of statements such as, "We are placing the following items in our records at an estimated value of ____________." For additional information concerning the valuation of gifts, it is recommended that the Department of the Treasury, Internal Revenue Service, be consulted.

### DEPOSITION OF VOUCHER SPECIMENS

A source of acquisitions that may be similar to a gift is material from individuals not associated with the collection who deposit voucher specimens. Such material can be a potentially valuable contribution to the collection, particularly when research or field data are associated with it. When voucher specimens are acquired by the collection, every effort should be made to obtain or gain access to all data concerned with the incoming specimens.

### PERMANENT AND LONG TERM LOANS

Permanent and long term loans represent types of acquisition that are not common among Recent mammal collections. Such acquisitions may result from various transactions between institutions or individuals. For instance, one institution may need to loan its collection to another institution because of the lack of facilities to maintain the collection (Van Gelder, 1965). Another possibility is that an institution may receive rare, endangered, or protected species from a state or federal agency. The main stipulation in accepting a permanent loan is that if the material is to be disposed of at a later date, it must be returned to the lender. Material on long term loan may be returned under similar circumstances, or with the expiration of the loan period, or upon request from the lender.

# PROCESSING

## ACCESSIONING

The accessioning procedure involves receiving and recording of all acquisitions by the institution (Fig. 2). The steps of this procedure may vary at different institutions.

An accession represents an acquisition from one source at one time, and may include material that consists of several different assemblages. For instance, material may be received from one field expedition and include a series of mammals, reptiles, plants, insects, or any other item obtained during the course of the trip. All this material would be included in one acquisition, or accession, and would therefore be recorded as a single unit received by the institution.

Each acquisition is given an accession number distinguishing it from other acquisitions. This number, in addition to relevant information concerning the acquisition, is recorded on an accession form (Fig. 3). The minimal information that should be recorded on an accession form would include the disciplines receiving material, list of material in the acquisition, brief description of the material in the acquisition, type of acquisition, estimated value, donor, address of donor, date received, date accepted, and special remarks. When collection catalog numbers become available, they should also be included on the accession form. Copies of collecting permits, importation permits, and custom declarations pertaining to the acquisition should be submitted with the accession form. These documents should become part of the institution's permanent records.

Once the accession form is completed, it is registered in the institution records. Registration of an accession may involve recording appropriate information in a ledger (Fig. 4) or card file, completing

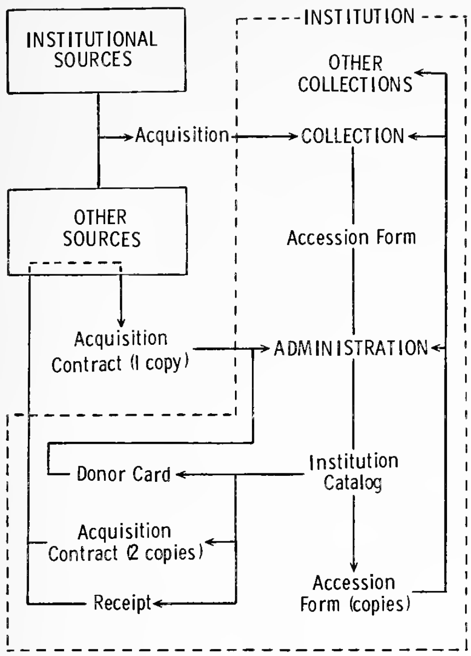



Fig. 2. Flow chart of accessioning procedures.

a donor card (Fig. 5), and duplicating the accession form. The donor cards are placed in a file arranged according to contributors. Copies of the accession form are kept in the institution and often with the collection or collections.

If an acquisition is received as a gift, a receipt (Fig. 6) and an acquisition contract (Fig. 7) should be sent to the donor. Similar procedures may also be applied to other types of acquisitions, depending on the nature of the individual transaction. Such procedures acknowledge the receipt of the acquisition, and release the institution from any additional obligation to the donor. In the event that a contract is not signed and returned, deaccessioning procedures may be conducted. This procedure involves returning the acquisition to the donor and adjusting all records to indicate that the material was deaccessioned (Fig. 4).

Although many institutions may not understand the need to practice accessioning, such procedures are useful in collection management. In addition to providing a record of all incoming material for the institution, accessioning allows the recording of information that would not be documented through othe processes (for example, donor, donor's address, estimated value, description, and other comments). Accessioning also promotes organization of the material for later processing and allows easy reference for compiling reports. Finally, accessioning procedures assure complete control and firm ownership of all incoming material. Because of the advantages created by accessioning, it is advisable to include similar procedures in the management of Recent mammal collections. After accessioning has been completed, the material in the acquisition is sent to the appropriate collection or collections for cataloging and subsequent processing (Fig. 8).

## CATALOGING

Cataloging procedures for most Recent mammal collections (for example, USNM, MVZ, WFBM, FSM, PUWL, MMNH, AMNH, CM, and TTU) includes a sequence of identifying, organizing, recording, and numbering each specimen of an acquisition. Depending on the nature of preparation, individual specimens may require minor alterations in cataloging procedures. Because "skin tags" may become damaged with specimens preserved as skeletal material or as "alcoholics," labeling of such material is generally restricted to the use of "skull tags" with appropriate identification (for example, initials of preparator, preparation number, and sex). As a result, other data are not available with the specimen. It is therefore necessary to temporarily substitute a label or card having the required information for the specimen. This substitution will allow the specimen to be processed through regular cataloging procedures. Once cataloged, such specimens need only to be labeled with the appropriate collection number.

### IDENTIFICATION

Identification of individual specimens is probably the first and most difficult phase of cataloging for most Recent mammal collections, and generally includes identification of each specimen to a subspecific level. All identifications are based on the most recent classification occurring in the literature. Hall and Kelson (1959) have written one of the best references for North American mammals, yet this work is in need of revision. If a specimen cannot be completely identified because of uncleaned skeletal material, the standard procedure is to partially identify the material as accurately as possible, and complete identification to the subspecific level, or specific level in the case of monotypic species, after the material has been cleaned in subsequent processing. When an identification is acquired, the name should be written on the skin tag (or substituting label). By using a pencil to write the identification, changes in the name caused by misidentification or taxonomic revision can easily be made.

Accession No. 1974-983 — Code Mamm., Ornith., Herp.

Date Rec'd. November 1974

Nature of Material 84 mammals, 22 birds, 2 reptiles preserved as skins and/or skel. or alcoholic

Rec'd From Museum Field Methods course — How Obtained field collection

Address The Museum; Texas Tech University; Lubbock

Correspondence Dr. Hugh H. Genoways — Field Notes available

Collector (see remarks) — When Collected Oct-Nov 1974

Locality Texas: Brewster Co., Glass Mountains

Estimated Value $540.00 — Inclusive Catalog Nos.

mammalogy 22902-22986.

ornithology 2594-2609, 2660,

herpetology

Dimensions

Remarks Collectors included *A.D. Bjelland, D.K. Dean, *R.C. Dowler, *H.H. Genoways, R.L. Hendricksen, M.H. McGaugh, E.F. Pembleton, S.E. Perkins, and *S.L. Williams; *possessed permits.

Date of Entry 10 November 1974 — Entered by rsm

Fig. 3. Standard accession card used by The Museum of Texas Tech University. Original size of card was 127 by 203 millimeters.

At other collections (for example, ROM, MHP, KU, UMMZ, and UPS), identification may be entirely postponed until after the skeletal material has been cleaned. Although this procedure may have some advantages (for example, conclusive identification and elimination of unsuitable specimens), particularly at collections having a restricted acquisition of new material, it is less efficient than the procedure described above, because of the delay in the initial processing (for example organizing, cataloging, labeling) of the acquisition. This delay is usually caused by the time required to clean the skeletal material, particularly when irregular time periods are needed for various specimens. Further expenditure of time and energy also occurs as a result of problems in reassociating, for initial processing, the skeletal material with other parts of the specimen (for example, skins), particularly when several acquisitions have been mixed. Depending on the control of cleaning operations, additional factors may cause further inefficiency as processing continues. But if such a procedure is feasible and is practiced, it is suggested that separate working cases, or areas within a case, be used for uncataloged material.

## ORGANIZATION AND ARRANGEMENT

After the specimens have been identified, they should be organized for cataloging. A common practice among Recent mammal collections is to catalog the specimens of an acquisition in an order approximating the arrangement of specimens in the collection.

Most arrangement plans are dependent upon several factors, such as size of collection, type of preservation, available facilities, staff size, nature of utilization, and fields of interest of the professional staff. Once a system has been adopted, it should prevail throughout the collection, wherever feasible, to promote continuity and accessibility. Written instructions should be posted and distributed to collection users. Following are the instructions for cataloging arrangement of mammal specimens at Texas Tech University:

> For any incoming accession, the mammal specimens of that accession will be arranged in the following manner for cataloging purposes:
>
> 1) Specimens are arranged systematically to subfamily following Simpson (1945).

| ACCESSION NUMBER | DONOR | DONOR ADDRESS | DIVISION | ARTICLE | VALUE | DATE RECEIVED | TYPE OF ACQUISITION | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1974-970 | S.L. Williams & E.F. Pembleton | The Museum and Dept. Biological Sciences; Texas Tech University | Mammalogy | 63 Pocket Gophers | $315 00 | May 1974 | field collection | ——— |
| 1974-971 | West Texas Museum Association | The Museum, Texas Tech University | Art; History | 4 watercolor paintings; 1 sculpture; 1 1920 phonograph | $2150 00 | May 1974 | purchase | ——— |
| Deaccessioned - Gift contract not signed and returned - Gift returned to donor on 28 November 1974 / RMJ | | | | | | | | |
| ~~1974-972~~ | ~~M.L. Walker~~ | ~~4017 20th, Abilene, Texas~~ | ~~History~~ | ~~1 Model-T Ford~~ | ~~$3500 00~~ | ~~May 1974~~ | ~~gift~~ | |
| 1974-973 | N.O. Ogleby | 307 Arburn Ave, Sweetwater, Texas | Entomology | 541 insects | $500 00 | June 1974 | gift | voucher specimens |
| 1974-974 | M.E. King | The Museum; Texas Tech University | Anthropology | 34 projectile points, 52 scrapers, 105 sherds; 13 grinding stones | $200 00 | Aug 1974 | field collection | from Lubbock Co, Tex |
| 1974-975 | West Texas Museum Association | The Museum; Texas Tech University | Art | 10 oil paintings; 10 prints | $575 00 | Sept 1974 | purchase | all pieces framed |
| 1974-976 | Phillips Petroleum Company | Bartlesville, Oklahoma 74004 | Geology | 25 core samples | $100 00 | Sept 1974 | gift | ——— |
| 1974-977 | Mr. & Mrs. A.C. Remington | 5027 E. Oak; Lubbock, Texas 79412 | Botany | 125 herbarium specimens from Iraq | $550 00 | Sept 1974 | gift | copies of permits acquired |
| 1974-978 | E.C. Birney | Bell Museum of Natural History, Univ. Minnesota, Minneapolis, Minnesota | Mammalogy | 1 bear skeleton | $50 00 | Sept 1974 | exchange | no specific data |
| 1974-979 | U.S. Fish & Wildlife Service | Dept. Interior; Washington D.C. | " | 1 sea otter (skin & body skeleton) | $300 00 | Sept 1974 | permanent loan | endangered species |
| 1974-981 | B.B. Davis | Box 430; San Diego, California | " | 97 bats from Sinaloa, Mexico | $150 00 | Oct 1974 | purchase | permits and field notes included. |
| 1974-982 | L.D. Shelby & T.G. Jacobson | 920 Ave T; Brownsville, Texas | Mamm; Herp | 129 mammals; 31 reptiles; 62 amphibians | $325 00 | Nov 1974 | gift | copies of pemits acquired |
| 1974-983 | Museum Field Methods course | The Museum; Texas Tech University | Mamm; Ornith; Herp | 84 mammals; 22 birds, 2 reptiles | $540 00 | Nov 1974 | field collection | field notes included |

Fig. 4. Accession catalog maintained by Texas Tech University. Note that the third item has been deaccessioned. Original page size was 186 by 395 millimeters.

**DONOR CARD**

NAME: Museum Field Methods course

ACC. NO.: 1974-983

ADDRESS: The Museum; Texas Tech University

DATE REC'D.: Nov. 1974

PHONE: 742-7208

ASSIGNED TO: Mammalogy
Ornithology
Herpetology

Description:

84 mammals, 22 birds, 2 reptiles

ACCESSIONED BY: rsm

DATE: 10 Nov. 1974

ACQUIRED BY: field coll.

Fig. 5. Donor card completed for each accession at Texas Tech University. Original size of card was 102 by 153 millimeters.

The Museum of
Texas Tech University

**RECEIPT**

THE MUSEUM ACKNOWLEDGES THE RECEIVING OF:

_x_ GIFT ___ PURCHASE ___ LOAN ___ EXCHANGE

___ OTHER: __________

FROM: L. D. Shelby and T. G. Jacobson
920 Ave. T
Brownsville, Texas

CONSISTING OF THE FOLLOWING:

129 mammals, 57 reptiles, and 62 amphibians
from South Texas and northern Mexico.
(Acc. No. 1974-982)

THE MUSEUM PLACES THESE ITEMS IN ITS RECORDS AT AN ESTIMATED VALUE OF $325.00.

RECEIVED BY: R. Montgomery RM

DATE: 5 Nov 1974

Fig. 6. Receipt sent to the donor acknowledging material received and giving estimated value of the material. Original size was 102 by 153 millimeters.

The Museum

of

Texas Tech University

P.O. Box 4499 Lubbock, Texas 79409 Phone (806) 742-5151

AGREEMENT FOR ACQUISITIONS RECEIVED
BY THE MUSEUM

In conformity with the policies adopted by The Museum of Texas Tech University, as recommended by the American Association of Museums, I hereby give and release unconditionally all of the items received herewith by The Museum. The Museum agrees to treat the items to its best advantage for exhibit, study, or other purposes and to maintain their condition and security in a manner consistent with the total museum program. In keeping with the University's policies, acceptance of any collection is forbidden if given under the conditions that it be kept intact, that it be exhibited permanently, or that The Museum keep it permanently.

5 November 19 74

Lawrence D. Shelby
Signature of Donor

R. Montgomery RLM
For The Museum

L. D. Shelby and T. G. Jacobson
920 Ave. T; Brownsville, Texas
Address

Registrar
Title

Description of Articles

129 mammals, 37 reptiles, and 62 amphibians from South Texas and northern Mexico. (Acc. No. 1974-982)

Fig. 7. Acquisition contract sent to all donors of material given to The Museum of Texas Tech University. Original size of page was 230 by 217 millimeters.

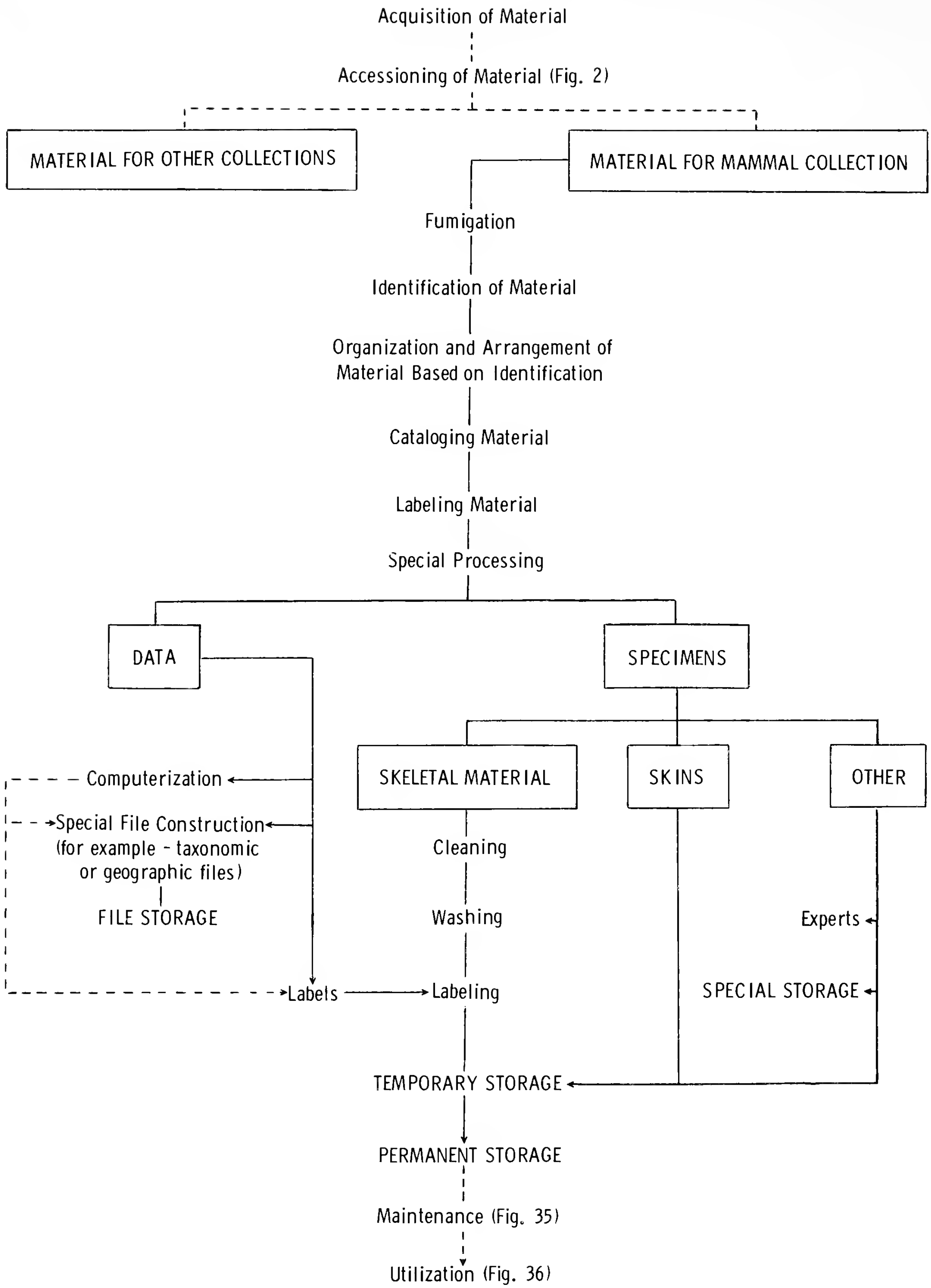



Fig. 8. Flow chart of processing procedures used in collections of Recent mammals.

2) Genera of a subfamily are arranged in alphabetical order.
3) Species of a genus are arranged in alphabetical order.
4) Subspecies of a species are arranged in alphabetical order.
5) Specimens of a subspecies are arranged in alphabetical order by country.
6) Specimens of the same country are arranged in alphabetical order by state, province, or department.
7) Specimens from the same state, province, or department are arranged in alphabetical order by county or parish, if such exists.
8) Specimens from the same county or parish (or state, province, or department, if counties or parishes are not used) are arranged alphabetically by locality with respect to the reference point (town, city, or physiographic feature) used on the specimen label.
9) When more than one locality refers to the same reference point, localities are arranged from north to south; if two or more localities are at the same latitude, the localities are arranged from west to east.
10) Specimens from the same locality are arranged alphabetically according to names of preparators (last name, first name, middle name).
11) Specimens of each preparator are arranged sequentially by preparation number.

The main advantage in having a detailed and definite cataloging procedure is that (1) any acquisition will be specifically organized for subsequent processing; (2) such procedures promote maximum efficiency of processing repetitive data, thus simplifying cataloging and computerization processes; and (3) such procedures allow any common group of specimens, once installed in the collection, to be in numerical order as well as in the order established for the collection, thus providing easier removal, replacement, and utilization of specimens.

Most collections (for example, USNM, MVZ, UCONN, MHP, KU, AMNH, CM, and TTU) arrange specimens in a phylogenetic order (Appendix A) according to Simpson (1945). A few Recent mammal collections use other sources of phylogenies: Anderson and Jones, 1967 (for example, OSMNH); Hall and Kelson, 1959 (for example, MMNH); Miller, 1924 (for example, UMMZ); Miller and Kellogg, 1955 (for example, UWZM); and Walker, 1975 (for example, FSM). Three of these phylogenies appear in Appendix B. Phylogenetic arrangements are advantageous because related taxa are kept in close proximity to one another. However, the use of the latter sources may be less desirable because of geographical restrictions, need of revision, or limited use among Recent mammal collections. Generally, phylogenetic arrangements are followed to the subfamilial or generic level. Problems in using a phylogenetic sequence to the generic level include the determination of relationships of genera that have recently been named or revised and maintaining a list of genera for reference purposes. An alphabetical sequence probably would be more practical to use because of the ease of retrieval and reinstallation for all people that may work in the collection. Most collections follow an alphabetical arrangement for species and subspecies.

Following a taxonomic arrangement, localities are arranged in some manner which may vary between different collections. One method, which originated at the Museum of Vertebrate Zoology at Berkeley, involves a geographical arrangement of localities from northwest to southeast, beginning with countries and following with the same arrangement within subsequent subdivisions (for example, state, county, reference point, and specific localities). This arrangement is shown in Appendix C. Another method (Appendix D) involves the alphabetical arrangement of localities beginning with countries, followed by alphabetizing within subsequent subdivisions (for example, state, county, and reference point). Specific localities around a common reference point are generally arranged from northwest to southeast. Geographical arrangement is sometimes preferred over alphabetical arrangement because of its utilization at other collections, or because the size of the collection using such a system does not warrant the change to more utilitarian systems because of the time and effort involved. However, alphabetical arrangement is more functional for most people, when considering collection management, and is therefore becoming popular among most Recent mammal collections (for example, USNM, UCONN, MHP, KU, MMNH, VMKSC, AMNH, CM, TTU, and UPS).

Although actual arrangement within a collection may follow a numerical order (by collection catalog number) following the locality, further detail in arranging specimens is recommended. Each specimen should have a specific position with the acquisition. This practice will contribute to the unity and organization of the acquisition. For instance, some

collections (for example, MHP and KU) may further subdivide the specimens chronologically by collecting date, followed by an alphabetical arrangement of preparators, which is in turn followed by a sequential order of preparation numbers. Some collections (for example, MMNH, AMNH, and TTU) simply subdivide specimens by preparator (alphabetically) and preparation number (sequentially).

### RECORDING

Cataloging is a process of allocating a specific sequential collection number to each specimen and all its parts. This number and pertinent information concerning the individual specimen are recorded in the collection catalog (Fig. 9), in permanent black ink. Generally, a catalog consists of bound pages that have sequential numbers on each line of each page. Each line is reserved for information corresponding to a single specimen. However, catalogs may have other forms, e.g., cards (Fig. 10) as maintained by the Texas Cooperative Wildlife Collection. This system (TCWC) is basically the same as the bound version except that the specimens are associated data are listed (numerically by catalog number) on 4″ x 6″ cards. Whatever type of catalog is used, basic information should be included, such as the collection catalog number, scientific name (for example, genus, species, subspecies), sex, collecting locality (for example, country, state or equivalent, county or equivalent, specific locality), collecting date, collector, preparator, preparation number, special numbers (for example, numbers associated with individual research projects, collector's number, previous collection catalog numbers from other institutions), type of preparation, and accession number. Other information that can be included is family, continent, longitude and latitude of collecting locality, reproductive data, external measurements, and ecological data. External measurements and reproductive information should be routinely included for specimens that do not have this information recorded elsewhere (for example, specimens labeled only with a "skull tag").

### NUMBERING

After a specimen has been assigned a number and recorded in the catalog, the collection name, or initials, and collection catalog number should be written with permanent black ink on all skin tags, skull tags, and special tags. For material such as traded or purchased specimens, the original tags are never replaced by new tags, but should be supplemented by such tags. This procedure is needed to identify the specimen with its respective collection and to maintain all records associated with the individual specimen. All parts of any particular specimen should be labeled and identifiable by the collection catalog number. If skeletal material is not completely clean at this point, labeling of the bones must await further processing. Because the collection catalog number represents a specific and permanent part of the collection, and it is the primary distinguishing character of the specimen, extreme care should always be taken to insure that all records and labels are legible and correct.

## PROCESSING DATA

Once specimens have been cataloged, additional records are often made for each specimen. Such records may include labels for skeletal material, special card files, or specimen information entered into a computerized information-retrieval system.

### LABELS

To to able to efficiently place skeletal material in its proper position within the collection, it is necessary to make special labels for such material. These labels may include the collection catalog number, taxon, sex, collecting locality, collecting date, preparator, and preparation number. If the skeletal material represents the entire specimen, external measurements and reproductive data should be included on the label (Fig. 11). The typing of labels for skeletal material can be done any time after cataloging. A good procedure is to type a series of labels in sequential order, proofread the typed information, file the labels in numerical order, and match the label with corresponding skeletal material when processing has been completed. This procedure will allow a check of what specimens have been completed and are ready for installation. Similar labels may also be used for special collections (for example, see STORAGE).

### FILES

Many Recent mammal collections also maintain additional records of cataloged specimens, such as geographic or taxonomic card files (Figs. 12 and 13). Geographic card files are usually arranged alphabetically, whereas taxonomic card files may be arranged alphabetically or phylogenetically. Although such files may be difficult to maintain because of the time required for duplicating information, they can provide a useful reference in utilizing the collection, or in responding to inquiries

CATALOG OF THE MAMMAL COLLECTION, TEXAS TECH UNIVERSITY, LUBBOCK, TEXAS
VOLUME 5 PAGE 180

| CATALOG NO | GENUS | SPECIES | SUBSPECIES | SEX | STATE | COUNTY | SPECIFIC LOCALITY | DATE COLLECTED | NATURE OF SPECIMEN | COLLECTOR | PREPARATOR | PREP NO | SPECIAL NO. | ACC. NO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22961 | Peromyscus | pectoralis | laceianus | ♀ | Texas | Brewster | 18.6 mi. N, 1.2 mi. E Marathon | 2 Nov 1974 | Alcoholic | S.L. Williams | NO-82-205-17=11.9 S.L. Williams | 1898 | — | 1974-983 |
| 22962 | " | " | " | ♂ | " | " | " | " | " | " | 156-79-20 5-16=11.9 " | 1899 | — | " |
| 22963 | " | " | " | ♂ | " | " | 18.5 mi. N, 1.3 mi. E. Marathon | 1 Nov 1974 | Skin & Skull | D.K. Dean | D.K. Dean | 80 | — | " |
| 22964 | " | " | " | ♂ | " | " | " | " | " | " | " | 81 | TK 7835 | " |
| 22965 | " | " | " | ♀ | " | " | " | " | " | " | " | 82 | — | " |
| 22966 | " | " | " | ♀ | " | " | " | " | " | " | " | 83 | — | " |
| 22967 | " | " | " | ♀ | " | " | " | " | " | " | " | 84 | — | " |
| 22968 | " | " | " | ♀ | " | " | " | 3 Nov 1974 | " | R.L. Hendricksen | R.L. Hendricksen | 405 | — | " |
| 22969 | " | " | " | ♀ | " | " | 18.0 mi. N, 1.2 mi. E Marathon | 2 Nov 1974 | " | M.H. McGaugh | M.H. McGaugh | 48 | — | " |
| 22970 | " | " | " | ♂ | " | " | 18.0 mi. N, 3.0 mi. E Marathon | 1 Nov 1974 | " | S.E. Perkins | S.E. Perkins | 49 | — | " |
| 22971 | " | " | " | ♂ | " | " | 17.3 mi. N, 0.6 mi. E. Marathon | " | " | S.L. Williams | S.L. Williams | 1865 | — | " |
| 22972 | " | " | " | ♂ | " | " | " | " | " | " | " | 1866 | TK 7836 | " |
| 22973 | " | " | " | ♂ | " | " | " | " | " | " | " | 1889 | — | " |
| 22974 | " | " | " | ♂ | " | " | " | " | " | " | " | 1890 | — | " |
| 22975 | " | " | " | ♂ | " | " | " | " | " | " | " | 1891 | — | " |
| 22976 | " | " | " | ♀ | " | " | " | " | " | " | " | 1892 | — | " |
| 22977 | " | " | " | ♀ | " | " | " | " | " | " | " | 1893 | — | " |
| 22978 | " | " | " | ♀ | " | " | " | " | Skeleton Only | " | [illegible] " | 1894 | — | " |
| 22979 | Urocyon | cinereoargenteus | scottii | ♂ | " | " | 18.0 mi. N, 3.0 mi. E Marathon | 2 Nov 1974 | Skin, Skull, & Body Skeleton | R.C. Dowler | R.C. Dowler | 56 | — | " |
| [illegible]80 | Bassariscus | astutus | flavus | ♂ | " | " | 18.0 mi. N, 3.0 mi. E Marathon | 3 Nov 1974 | " | E.E. Pembleton | S.L. Williams | 1872 | — | " |
| 22981 | " | " | " | ♂ | " | " | 17.9 mi. N, 0.3 mi. E Marathon | 1 Nov 1974 | " | S.L. Williams | " | 1871 | — | " |
| 22982 | " | " | " | ♂ | " | " | 17.3 mi. N, 0.6 mi. E Marathon | 2 Nov 1974 | " | M.H. McGaugh | M.H. McGaugh | 77 | — | " |
| 22983 | Conepatus | mesoleucus | mearnsi | ♀ | " | " | 18.6 mi. N, 1.2 mi. E Marathon | " | " | S.L. Williams | S.L. Williams | 1873 | — | " |
| 22984 | Mephitis | mephitis | varians | ♂ | " | " | 18.0 mi. N, 3.0 mi. E Marathon | 3 Nov 1974 | Skin & Skull | M.H. McGaugh | M.H. McGaugh | 78 | — | " |
| 22985 | Tayassu | tajacu | angulatus | – | " | " | " | 1 Nov 1974 | Cranium Only | R.C. Dowler | R.C. Dowler | 50 | — | " |

Fig. 9. Completed collection catalog page used at The Museum of Texas Tech University.

**Department Catalogue—MAMMALS** **Texas A&M University**

Acc'n. No. 600 Date of Entry 21 May 1969 Entered by S. Richards

General Locality Texas

| Dept. No. | Orig.No. | Name | Date | Collector | Exact Locality |
|---|---|---|---|---|---|
| 22856 | 425 | Bassariscus astutus flavus | 22 July 1967 | H.M. Ohlendorf | 8 mi NE Candelaria Presidio Co., Texas |
| skull only 22857 | 686 | " | 31 January 1968 | T.C. Maxwell | " |
| skull only 22858 | 424 | " | 22 July 1967 | H.M. Ohlendorf | " |
| skull only 22859 | 222 | " | 25 March 1967 | " | " |
| skull only 22860 | 353 | Procyon lotor mexicanus | 8 July 1967 | " | " |
| 22861 | 418 | Spilogale gracilis gracilis | 21 July 1967 | " | " |
| skull only 22862 | 394 | Conepatus mesoleucus mearnsi | 15 July 1967 | " | 9 mi. NE Candelaria Presidio Co., Texas |
| skull only 22863 | 907 | " | 28 January 1968 | " | 8 mi NE Candelaria Presidio Co., Texas |
| skull only 22864 | 298 | " | 5 July 1967 | " | " |
| skull only 22865 | 299 | " | 7 July 1967 | " | " |

Fig. 10. Numerical catalog maintained on 4" x 6" cards at Texas Cooperative Wildlife Collection, Texas A & M University.

concerning the collection. As the collection grows in size, such files become even more important.

COMPUTERIZATION

In an effort to gain better utilization of systematics collections, many Recent mammal collections (for example, USNM, KU, and TTU) are entering information and data of cataloged specimens into computerized information-retrieval systems. Interest in the use of computers for the purpose of collection utilization and management has been further developed by the American Society of Mammalogists (1974). In an effort to obtain the maximum and most efficient use of data associated with specimens in collections, a national information-retrieval network has been proposed. Such a network would involve all North American Recent mammal collections and basically entail recording and storing data from all mammal specimens. These data will be accessible to all qualified workers and can be reproduced in written form. To operate the proposed network, several regional centers would be required for the compilation of information of surrounding collections. A national information-retrieval network would certainly be advantageous for Recent mammal

Skin & Skull
Texas Tech 22977 ♀ University
Peromyscus pectoralis
laceianus
Texas:Brewster Co., 17.3
mi N, 0.6 mi E Marathon
The Museum S.L.Williams
1893

Skeleton Only
Texas Tech 22973 ♀ University
Peromyscus pectoralis
laceianus
Texas:Brewster Co., 17.3
mi N, 0.6 mi E Marathon
The Museum S.L.Williams 1894
180-86-21-18=23.7 3emb=7

Fig. 11. Two examples of labels used for skeletal material stored in vials. Original size was 28 by 50 millimeters.

Locality TEXAS: Brewster Co. #4

The Museum of Texas Tech University
COLLECTION OF MAMMALS

| Number | Name | Date | Collector |
|---|---|---|---|
| 8023 | Perognathus nelsoni canescens | 9 Apr 1968 | R.J. Baker |
| 8584 | Sigmodon ochrognathus ochrognathus | 16 Apr 1968 | H. Bowers |
| 10447 | Euderma maculatum | 7 Jul 1970 | D.A. Easterla |
| 12090 | Peromyscus eremicus eremicus | 18 Apr 1966 | C.O. McKinney |
| 12158-12162 | Antrozous pallidus pallidus | 19 Sept 1970 | J.W. Warner |
| 13698 | Conepatus mesoleucus mearnsi | 5 Jan 1968 | R.L. Packard |
| 17732-17733 | Pappogeomys castanops pratensis | 29 Jul 1969 | O.J. Reichman |
| 22902 | Myotis velifer incautus | 2 Nov 1974 | R.C. Dowler |
| 22903-22904 | Pipistrellus hesperus maximus | 2 Nov 1974 | S.L. Williams |
| 22905 | Lepus californicus texianus | 1 Nov 1974 | S.E. Perkins |
| 22906 | " " " | " | R.C. Dowler |
| 22907 | " " " | " | M.H. McGaugh |
| 22908 | " " " | 2 Nov 1974 | R.L. Hendricksen |
| 22909 | Sylvilagus audubonii neomexicanus | " | S.L. Williams |
| 22910 | Ammospermophilus interpres | 1 Nov 1974 | R.L. Hendricksen |

Locality TEXAS: Brewster Co. #5

The Museum of Texas Tech University
COLLECTION OF MAMMALS

| Number | Name | Date | Collector |
|---|---|---|---|
| 22911 | Ammospermophilus interpres | 2 Nov 1974 | S.L. Williams |
| 22912 | " " | 3 Nov 1974 | M.H. McGaugh |
| 22913 | Pappogeomys castanops pratensis | " | R.C. Dowler |
| 22914 | " " " | 31 Oct 1974 | M.H. McGaugh |
| 22915-22916 | " " " | 1 Nov 1974 | S.L. Williams |
| 22917 | " " " | 31 Oct 1974 | " |
| 22918 | Thomomys bottae limitaris | " | R.C. Dowler |
| 22919 | " " " | " | R.L. Hendricksen |
| 22920 | " " " | 2 Nov 1974 | S.L. Williams |
| 22921-22927 | " " " | 1 Nov 1974 | " |
| 22928 | " " " | 2 Nov 1974 | " |
| 22929 | " " " | 3 Nov 1974 | " |
| 22930 | " " " | 31 Oct 1974 | R.L. Hendricksen |
| 22931-22933 | " " " | 2 Nov 1974 | S.L. Williams |
| 22934 | Perognathus flavus flavus | " | R.C. Dowler |

Fig. 12. Two cards from the geographic card file. Original size of card was 128 by 178 millimeters.

Mephitis mephitis varians #2

The Museum of Texas Tech University
COLLECTION OF MAMMALS

| Number | Sex | Locality | Date | Collector |
|---|---|---|---|---|
| 1839 | ? | Texas: Llano Co., 7.5 mi. S Llano | 31 Mar 1965 | H.S. Myrick |
| 8518 | ♂ | Texas: Martin Co., 3 mi. N Stanton | 26 Dec 1968 | S.L. Williams |
| 10247 | ? | Tamaulipas: 67 km. S Cd. Victoria | 2 Apr 1970 | V.R. McDanial |
| 10265 | ♂ | Texas: Lubbock Co., 5 mi. S Wolfforth | 23 Feb 1970 | T.E. Clark |
| 12063 | ♂ | Texas: Presidio Co., Sierra Vieja Mts., ZH Canyon | 19 Sept 1968 | R.J. Baker |
| 12064 | ♂ | Texas: Archer Co., 26.4 mi. SW Wichita Falls | 22 Nov 1970 | " |
| 17411 | ♂ | Texas: Jeff Davis Co., 1/2 mi. NE Fort Davis | 30 Sept 1972 | S.L. Williams |
| 17490 | ? | Texas: Lubbock Co., Lubbock | 7 May 1973 | P. Montgomery |
| 20687 | ♀ | Texas: Culberson Co., Upper Dog Ranger Station, Guadalupe Mts. National Park | 4 Jun 1973 | R.J. Baker |
| 20688 | ♂ | Texas: Culberson Co., Williams Ranch Guadalupe Mts. National Park | 15 Jun 1973 | D.E. Wilhelm |
| 22984 | ♂ | Texas: Brewster Co., 18.0 mi. N, 3.0 mi. E Marathon | 3 Nov 1974 | M.H. McGaugh |

Fig. 13. Card from the taxonomic card file. Original size of card was 128 by 178 millimeters.

collections, but its success is largely dependent on the cooperation and standardization of such collections.

In order to establish standardization and plan a national network, the American Society of Mammalogists sponsored a workshop for the National Network for Information Retrieval in Mammalogy (NIRM) in September 1975. One result of this workshop was the selection of data that will be used by NIRM. The types of data, generally recorded for mammals, were divided according to individual importance, and classified as being mandatory data, important (but optional) data, and other optional data (Table 2). The optional data is not used by NIRM because of the expense and security involved. Implementation of these categories is dependent on the need and discretion of the individual collection. The standards established for the various types of data have been documented, and include explanations of descriptions, formats, omit conditions, contingency requirements, valid examples, accepted variations, and occasional remarks. This documentation was primarily developed at the National Museum of Natural History by Art Brigida and Henry W. Setzer, and will become available through the Committee on Information Retrieval of the American Society of Mammalogists.

The information retrieval system proposed by NIRM for the national network is SELGEM (SELf GEnerating Master) which was designed and developed by the Smithsonian Institution for information management. SELGEM consists of about 25 general-purpose computer programs, which are written in the COBOL (COmmon Business Oriented Language) computer language. These programs can be made compatible with several types of computers (for example, Honeywell 2015, IBM 360, IBM 370, CDC 3100, CDC 6400, UNIVAC 1106, UNIVAC 1110, GE 635, Burroughs, and ICL) as long as at least four tape drives, 96 K characters of

TABLE 2. SELGEM CATEGORIES[1] AND NUMBERS AS USED AT NATIONAL MUSEUM OF NATURAL HISTORY AND TEXAS TECH UNIVERSITY.

| Category Number | Category | Category Number | Category |
|---|---|---|---|
| *001 | Catalog/Serial Number | 112 | Elevation |
| *051 | Museum Acronym | 125 | Collector's Name |
| 052 | Division Acronym | 126 | Collector's Number |
| *053 | Catalog/Serial Number | 155 | Donor |
| 065 | Family | 156 | Accession Number |
| *071 | Genus | 157 | Date Cataloged |
| 073 | Subgenus | 185 | Ecological Notes |
| *075 | Species | 200 | Remarks |
| 078 | Subspecies | *401 | Sex |
| *095 | Date Collected | 402 | Collection Code |
| *100 | Continent or Country | | (Type of Preparation) |
| *102 | State or Province | 403 | Bone Inventory |
| *103 | Country, District, or | 404 | Weight |
| | Major Island Group | 405 | Reproductive Anatomy Data |
| 104 | Specific Locality | 406 | External Measurements |
| 106 | Modifier of Specific Locality | 410 | Age |
| *107 | Ocean | 420 | Corresponding Bone or |
| *108 | Sea | | Skin Number |
| *109 | Bay, Inlet, Strait, Estuary, | 506 | Preparator's Name |
| | Gulf, or Channel | 508 | Preparation Number |
| 110 | Latitude and Longitude | 510 | Special Number |

[1]Categories marked with an asterisk are mandatory for NIRM.

core, and a COBOL compiler are available (Anon., 1974; Chenhall, 1975). Based on the type of computer utilized, the cost of implementation ranges from $500 to $5,000. The programs may be acquired from the Smithsonian Institution at no cost other than the cost of duplication. For this service and because of federal obligations to the public, the SELGEM programs may not be used for profit-making purposes. The current cost of each record from the time of input to the final output is about $0.31 per record at the Smithsonian Institution (Anon., 1974). It is possible that data for specimens can be processed cheaper.

Although SELGEM is a popular program among systematics collections, there are several other computerized information-retrieval systems (for example, MARK IV, GRIPHOS, GIPSY, ELMS, STIRS, GIS, ADAM-II, CAP, CORSAIR II, ISIS, IRGMA, and IGMRAF) which possibly could be used by mammal collections if needed modifications are made. The suitability and utilization of any particular program is primarily determined by the requirements and resources of the individual collection or institution. When selecting a computer program for information-retrieval purposes, several factors should be considered before any program is implemented. These factors include:

1) Source and availability program
2) Success of program at other institutions
3) Past, current, and future support and development of the program
4) Actual needs of the collection or institution
5) Applicability and suitability of the program to meet the needs of the collection or institution
6) Alternative uses of the program (for example, payroll, mailing lists, etc.)
7) Capabilities and functions of the program (for example, compiling, searching, sorting, updating, editing, report writing, label writing, etc.)
8) Flexibility of the program to permit change to the needs of the collection or institution
9) Convertibility of the program (for example, integrating stored data from one program with other information-retrieval computer programs or statistical programs)
10) Complexity of the program (for example, input and output operations, utilization, and maintenance)
11) Security of stored records and other documentation

12) Time required (for example, implementation of the program, capturing data, and using data)

13) Required personnel

14) Time and effort required to train personnel

15) Costs (for example, initial, recurring, operating, processing, etc.)

16) Administrative financial support and cooperation

17) Cooperation of users

18) Availability of support and cooperation for the program and computerization over an extended period of time

19) Compatibility of program with available hardware

For a basic tabular comparison of some computerized information-retrieval systems, see Appendix E.

Although procedures in computerization can be complex, depending on the situation, the basic steps for many information-retrieval systems (including SELGEM) include initial planning, coding of data, translating coded data, creating working files to remove discrepancies from the captured data, building, or adding to a master file with corrected data, and utilizing the data in the master file. Depending on the program and the situation for which the program is used, these steps may vary somewhat.

The initial planning of computerization should begin with study of the literature (Chenhall, 1975; Ellin, 1970/71; Foote and Zider, 1975; Hislop, 1967; Squires, 1970; Vance *et al.,* 1973; Van Gelder and Anderson, 1967), of other collections that are actively utilizing computers, and discussion with computer experts. If the SELGEM system is to be implemented, it is recommended that the Smithsonian Institution be consulted (address: Manager, Information Retrieval and Indexing, Information Systems Division, Smithsonian Institution, A & I Building, Room 2362, Washington, D.C. 20560). One aspect of the initial planning may include data modifications acceptable to the computer (for example, the sex symbols "♂" and "♀", will need to be indicated in a different manner, e.g., "M" and "F"). Further data modification may include the addition of general categories, such as family and country, that will facilitate more convenient and less expensive retrieval of data. Because the initial planning for successful computerization may be difficult, particularly for inexperienced individuals, a set of basic guidelines to assist the various collections in starting computerization should be established.

Coding of the data consists of a standard designation, or category number, for each type of data or category (for example, see standard category numbers established by NIRM in Table 2). The use of the code simplifies utilization of computerized data. Because actual coding of data can be relatively involved, the specimen information may be transferred to coded worksheets (Fig. 14). However, such duplication may be time-consuming. Alternative methods include designing special catalog sheets that are already coded (Fig. 15), or coding data from the specimen directly into a computer-readable form (for example, paper cards, paper tape, etc.). Such methods require a well-trained technician that understands the cataloging and coding systems well enough for translation procedures.

Translation of data into computer-readable form may be done through the use of paper tape, paper cards, magnetic tape, magnetic cards, teletype, magnetic disk, and in other ways. Each method has advantages and disadvantages. The choice of any method should be governed primarily by the resources of the institution, compatibility with available computer hardware, and the information-retrieval program being used. For most situations, the standard key-punch machine for paper cards is probably the best all-around device for translating data. Further consideration in using any particular device should include an evaluation of equipment cost, processing cost, products, cost of products, complexity, ease of training, ease of making corrections, time required for utilization, terminal capabilities, and alternative uses.

The translated version is submitted to the computer, and a temporary file created. The file is used to adjust, correct, delete, or add information concerning the specimens. Once the information is in the desired form, it is added to the master file. If the master file is not new it will contain all information of previously computerized specimens. With the master file built, the information in the file can be manipulated in several ways to produce the desired output. For instance, numerical catalogs, geographical files, taxonomic files, special collection files, listings, or reports can be constructed. By supplementing this facility with a procedure for reduction of the printed record (for example, by photographic processes), labels (Fig. 16) can be made. There are several additional options available through the use of computerized information-retrieval programs. For instance, the University of Arizona at Tucson has developed a SELGEM

DATA SHEET
DIVISION OF MAMMALOGY
TEXAS TECH UNIVERSITY

Header $    Partial $    Regular $R

| | | |
|---|---|---|
| Museum | +051 | TTU |
| Division | +052 | M |
| Catalog Number | +053 | 22979 |
| Family | +065 | Canidae |
| Genus | +071 | Urocyon |
| Species | +075 | cinereoargenteus |
| Subspecies | +078 | scottii |
| * Sex | +401 | M |
| Continent or Country/Ocean | +100/~~+107~~ | United States |
| State or Province/ Sea | +102/~~+108~~ | Texas |
| County, District, or Major Island Group/ Bay, Inlet, Strait, Estuary, Gulf, or Channel | +103/~~+109~~ | Brewster |
| Specific Locality | +106 | 18.0 mi N, 3.0 mi E Marathon |
| Date | +095 | 02 Nov 1974 |
| ** Type of Preparation | +402 | SB |
| Collector | +125 | Dowler, R C |
| Preparator | +506 | Dowler, R C |
| Preparation Number | +508 | 56 |
| Special Number | +510 | |
| Accession Number | +156 | 1974-983 |
| Availability Status | +501 | |
| Remarks | +200 | |

End of Record ⌗    End of File ☐

* Code for Sex – M = male; F = female; ? = unknown

** Code for Type of Preparation –

AL = alcoholic
AN = anatomical
CO = cranium only
KB = skin and body skeleton
OT = other
PS = partial skeleton
SA = skull and alcoholic skin
SB = skin, skull, and body skeleton
SK = skull only
SN = skeleton only
SO = skin only
SS = skin and skull

Fig. 14. Form used for coding data for computerization using the SELGEM system. Original size of form was 280 by 217 millimeters.

CATALOG OF THE MAMMAL COLLECTION, TEXAS TECH UNIVERSITY, LUBBOCK, TEXAS
VOLUME 5 PAGE 120

| + 051 MUS | + 052 DIV | + 053 CATALOG NO. | + 065 FAMILY | + 071 GENUS | + 075 SPECIES | + 078 SUBSPECIES |
|---|---|---|---|---|---|---|
| TTU | M | 22961 | Cricetidae | Peromyscus | pectoralis | laceianus |
| TTU | M | 22962 | " | " | " | " |
| TTU | M | 22963 | " | " | " | " |

A

SEX CODE
M = MALE
F = FEMALE

A'

| + 401 SEX | + 100 COUNTRY | + 102 STATE | + 103 COUNTY | + 106 SPECIFIC LOCALITY |
|---|---|---|---|---|
| F | United States | Texas | Brewster | 18.6 mi N, 1.2 mi E Marathon |
| M | " | " | " | " |
| M | " | " | " | 18.5 mi N, 1.3 mi E Marathon |

B

NATURE OF SPECIMEN CODE
AN = ANATOMICAL
SK = SKULL ONLY
SO = SKIN ONLY
SS = SKIN AND SKULL
SN = SKELETON ONLY
BS = POST CRANIAL SKELETON ONLY
KB = SKIN AND BODY SKELETON
SB = SKIN, SKULL, AND BODY SKELETON
AL = ALCOHOLIC
SA = SKULL AND ALCOHOLIC SKIN
CO = CRANIUM ONLY

B'

| + 095 DATE COLLECTED | + 406 N.S. | + 125 COLLECTOR | + 506 PREPARATOR | + 508 PREP. NO. | + 510 SPECIAL NO. | + 156 ACC. NO. |
|---|---|---|---|---|---|---|
| 02 Nov 1974 | AL | S.L. Williams | S L Williams | 1898 | – | 1974-983 |
| " | AL | " | " | 1899 | – | " |
| 01 Nov 1974 | SS | D K Dean | D K Dean | 80 | – | " |

Fig. 15. Headings for catalog sheet designed at Texas Tech University. The design of this sheet expedites coding of data for computerization using the SELGEM system, thus eliminating the need for individual data sheets (Fig. 14). Original size of entire catalog page was 303 by 609 millimeters.

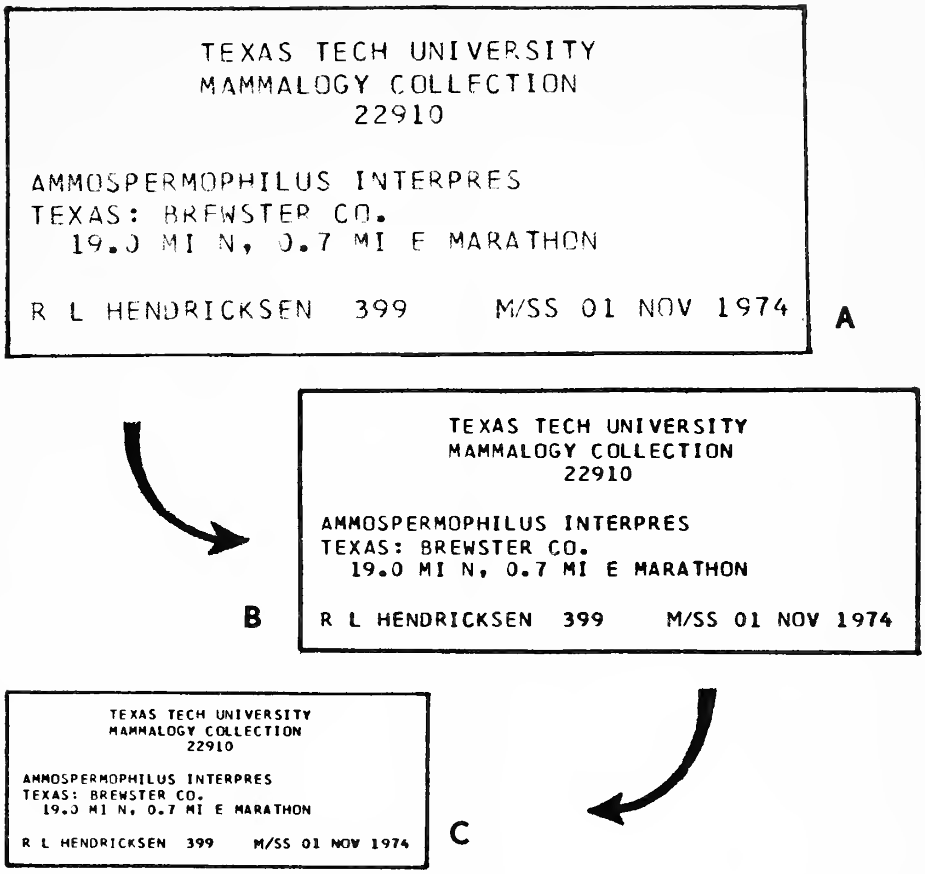



Fig. 16. Computer-generated label used on storage containers for skeletal material (see also Fig. 11). A. Actual size as printed by computer. B. 25% reduction of original. C. 50% reduction of original.

dependent program called REGIS that is used for accessioning purposes (see ACCESSIONING).

## PROCESSING SPECIMENS

When cataloging procedures are completed, all the material in the accession is prepared for further processing. Depending on the nature of the material, processing may vary considerably.

### FLUID-PRESERVED MATERIAL

Fluid-preserved specimens, often referred to as "alcoholics," are soaked in fresh water to remove fixatives, such as 10% formalin (Anderson, 1965; Quay, 1974), so that the specimens can be transferred to a permanent preservative. The standard preservatives used in most Recent mammal collections are 70% ethyl alcohol, 45% isopropyl alcohol, or occasionally 10% buffered (with borax, heximine, sodium phosphate, or ammonia solution) formalin (Anderson, 1965). Because of the expense and the need for tax clearance and security measures, isopropyl alcohol is becoming more popular than ethyl alcohol.

Once specimens have been washed and transferred to alcohol, they are grouped typologically and each taxon is placed in a jar of appropriate size. After each group has been placed in a jar, a sufficient amount of preservative is added to prevent desiccation.

Because identification of individual specimens in a jar is relatively difficult, a label is needed. The label must be of a high-quality paper (Dowler and Genoways, 1976; Sawyer, 1974) to insure durability and retention of the printing or inscription on the label when immersed in liquids (Anderson, 1965). The minimum of information that should be recorded on the label, for easy retrieval, is the taxon, collection numbers, and collecting localities of the enclosed specimens (Fig. 17). After the specimens

TEXAS TECH UNIVERSITY
THE MUSEUM

Peromyscus pectoralis laceianus
SPECIES

| CAT. NO. | LOCALITY |
|---|---|
| 20599 - 20602 | Texas: Culberson Co., Guadalupe Peak Campground, Guadalupe Mts. National Park |
| 20603 - 20605 | Texas: Culberson Co., Lost Peak Guadalupe Mts. National Park |
| 22961 - 22962 | Texas: Brewster Co., 18.6 mi N, 1.2 mi E Marathon |
| | |

M-C-1

Fig. 17. Label which is placed in jar with fluid-preserved specimens. Original size of label was 64 by 127 millimeters. Another size, 95 by 140 millimeters, is used for labeling larger jars.

have been properly preserved, contained, and labeled, they are ready to be installed in the collection.

On occasion, anatomical parts or skeletal material are removed from alcoholic specimens. When this is done, the removed material should be labeled with the name or acronym of the collection (Choate and Genoways, 1975) and the collection's catalog number, and then, depending on the nature of the material, incorporated in appropriate processing procedures. For instance, skulls removed from alcoholic specimens will be tagged, cleaned, washed, labeled, and placed in an appropriate container.

## SKINS

Generally, skins are prepared either as study skins or raw hides. If they are prepared as study skins, then further processing is minimal. This consists primarily of maintaining the skins in temporary storage until other parts of the specimen, such as skeletal material, are processed and matched with respective skins. For any material in temporary storage, arrangement in numerical order by collection catalog number facilitates further work and retrieval of any specimen.

Processing of raw hides is more complicated because tanning procedures are often required, and therefore can be expensive and time-consuming. Because tanning operations have been described in the literature (Anderson, 1965; Dimpel, 1971; Elwood, undated; Farnham, 1944, 1950, undated; Fries, 1973; Grantz, 1960, 1969; Johnson, 1973) it is possible for a collection to tan its own skins. However, it is often more practical to have such work done commercially (Dowler and Genoways, 1976; Van Gelder, 1965). If commercial sources are used, it is recommended that such sources be familiar with the special requirements of scientific specimens. When tanned skins are received, they may also be placed in their proper sequence in the temporary storage facilities.

## SKELETAL MATERIAL

Processing of skeletal material is probably the most complex and time-consuming activity of Recent mammal collections. When most skeletal material is acquired, it usually includes dried tissue connected to the bone. The removal of this tissue, and cleaning of the skeletal material makes this phase of collection operations tedious. (Because of this, any effort to remove nonskeletal tissues, such as muscles, blood, and brains, during initial field preparation can expedite later processing of skeletal material.) In an effort to improve the efficiency of processing skeletal material, several techniques have been developed.

CLEANING BY MACERATION: One method of cleaning skeletal material is by maceration, which involves keeping the material immersed in water until all flesh decays. Although this technique requires little effort, the disadvantages do not support its use. Maceration often causes disarticulation and discoloration of bones, offensive odors, and requires considerable time for completion (Anderson, 1965; Anon., 1958; Hildebrand, 1968; Knudsen, 1966; Thompson and Robel, 1968).

CLEANING WITH CHEMICALS: Partially because of the problems of straight maceration, numerous modifications have been developed to minimize its deficiencies. The primary changes have been the application of heat (Anderson, 1965; Brown and Twigg, 1967; Hildebrand, 1968; Howell, 1920; Knudsen, 1966) or the use of heat in conjunction with various chemicals, such as Clorox (Gross and Gross, 1966), trypsin, pancreatin (Hildebrand, 1968), cresylic acid (Holden, 1914, 1916), hydrogen peroxide (Howell, 1919), ammonium hydroxide (Hoffmeister and Lee, 1963), potassium carbonate (Iverson and Seabloom, 1963), sodium perborate (Jakway *et al.*, 1970), papain (Luther, 1949), dibasic anhydrous sodium phosphate with trypsin (Watson and Amerson, 1967), and enzyme-activated detergents (Ossian, 1970). These modifications have reduced processing time, offensive odors, and discoloration of bones. However, the potential damage of skeletal material caused by handling or by excessive soaking and boiling tends to depreciate the value of these methods (Gross and Gross, 1966; Hooper, 1956; Luther, 1949). In the case of enzyme-activated detergents, it has been noted (CM) that after an extended time following cleaning with such detergents, skeletal material starts showing signs of deterioration that lead to destruction beyond use. It has been suggested that the reason for this is that the enzymes continue work even after cleaning has been completed. Under certain circumstances, such as the cleaning of large postcranial bones, the methods described above may prove to be more useful.

CLEANING WITH LIVING ORGANISMS: Other developments in the processing of skeletal materials led to the use of living organisms to do the primary cleaning. Organisms that have demonstrated capabilities of cleaning skeletal material include ants, isopods (Bolin, 1935), decapods (Sealander and Leonard, 1954), clothes moths (Banta, 1961), mealworms (Allen and Neill, 1950), and dermestid beetles (Borell, 1938; Hall and Russell, 1933; Hildebrand, 1968; Hooper, 1956; Laurie and Hill, 1951; Sommer and Anderson, 1974; Tiemeier, 1940). Although all these techniques have been successful to some degree, certain problems may occur when using any method.

Ants (Hymenoptera: Formicidae) are capable of quickly and thoroughly cleaning skeletal material and are easily acquired and maintained (Peterson, 1964). However, the use of ants is not recommended because of the secretion of formic acid deposited on the skeletal material as it is being cleaned by the ants. This acid will either cause or contribute to the disarticulation of bones.

The use of crustaceans, such as isopods (Bolin, 1935) or decapods (Sealander and Leonard, 1954), is greatly limited by several factors. One problem is acquiring the organisms and maintaining a suitable environment (generally aquatic) for them. If too much skeletal material is placed in the holding container, maceration will begin, thus causing the water to be polluted, and ultimately causing the death of the organisms and disarticulation of the skeletal material. Another problem is selecting individuals that are not large enough to damage the skeletal material (Sealander and Leonard, 1954). Although the use of crustaceans has several limitations, it does serve to illustrate the diversity of organisms that may be used in cleaning skeletal material.

The clothes moth (Lepidoptera: Tineidae) may also be successfully used in preparing osteological specimens (Banta, 1961). In addition, these insects are easily acquired and maintained (Griswold, 1933; Heal, 1942; Peterson, 1964). Because of the habits of clothes moths, a severe problem can develop if this insect is allowed to infest the collection. Infestation is facilitated by the mobility of the adults and the small inconspicuous size of the larvae. For this reason, strict control of the colony and regular fumigation of the collection are necessary if clothes moths are to be used (see MAINTENANCE—Fumigation).

Utilization of mealworms (Coleoptera: Tinebrionidae) for cleaning osteological specimens allows easy control and maintenance of skeletal processing (Allen and Neill, 1950; Peterson, 1964). Under suitable conditions, this technique can be very effective, resulting in thorough and rapid cleaning of skeletal material. For the best results, it is better to let the mealworms clean the material while it is fresh or moist. However, to do so creates a potential mildew problem that can be toxic to the mealworms (Peterson, 1964). Special care also needs to be taken to prevent small skulls from being damaged by the larger mealworms. Because of this, the utilization of mealworms would probably be most useful in processing only larger specimens.

Dermestids (Coleoptera: Dermestidae) probably have provided the most generally favorable results in osteological cleaning. Not only do dermestids satisfactorily clean all sizes of skeletal material, but they are also easily acquired and, with proper facilities, controlled and maintained. As a result, this

method of skeletal preparation has been discussed in detail in the literature and has become a standard procedure in many Recent mammal collections. This method of cleaning skeletal material has not only proven to be superior to other techniques (Hall and Russell, 1933; Hildebrand, 1968; Hooper, 1950; Tiemier, 1940) but has also been useful in cleaning other types of skeletal material, such as mummified (Case, 1959) or alcoholic (de la Torre, 1951) specimens. Generally, such special specimens must be soaked for several hours, air dried, and coated with fat. Hooper (1956) found cod liver oil and bacon grease to be among the best fats to use. Because of the importance of dermestids, various studies and observations concerning their use, maintenance, and natural history have been described (Grady, 1928; Heal, 1942; Peterson, 1964; Roth and Willis, 1950; Russell, 1947; Sommer and Anderson, 1974). Russell (1947) recommends that, ideally, dermestids should be kept in a dark area at a temperature of 18.2° to 29.3°C (65° to 85°F). The availability of moisture for adult dermestids is necessary for egg production (Russell, 1947), which is necessary if the colony is to be maintained. However, a lack of moisture will cause a longer larval period (Roth and Willis, 1950), which would be desirable. Because of this paradox, Texas Tech University has maintained a very active dermestid colony on a restricted basis. Adults are removed from the main dermestid colony and are used for establishing smaller breeding colonies with more suitable conditions (Peterson, 1964). By supplementing the main colony with the breeding colonies that have larvae, a high concentration of larvae can be maintained, thus expediting the cleaning process and obtaining maximum utilization of adult and larval dermestids.

Because dermestids are so effective in cleaning skeletal material, certain precautions must be taken to prevent damage to delicate skeletal material, damage to tags, and loss or mixing of disarticulated skeletal material. Damage to specimens and tags can be restricted by regular examination of the cleaning process. Further restrictions can be implemented by applying formalin to tags and body parts (for example, joints, to prevent disarticulation) to control the rate of feeding by dermestids (Sommer and Anderson, 1974). To prevent loss or mixing of specimen parts, each specimen should be stored with cotton in separate containers (Scheffer, 1940; Sommer and Anderson, 1974). The use of cotton provides additional protection for the skeletal material, protection for the dermestids, suitable habitat for molting and pupating, and restricts the accumulation of debris on the specimens (Sommer and Anderson, 1974). Because storage of individual specimens in separate containers can lead to waste of space, disorganization of material, and difficulty in utilization, Texas Tech University has developed special trays having movable partitions that allow adjustment of compartment sizes to the size of the specimen (Fig. 18). These trays can be nearly stacked and can hold several hundred specimens in a neat and orderly fashion.

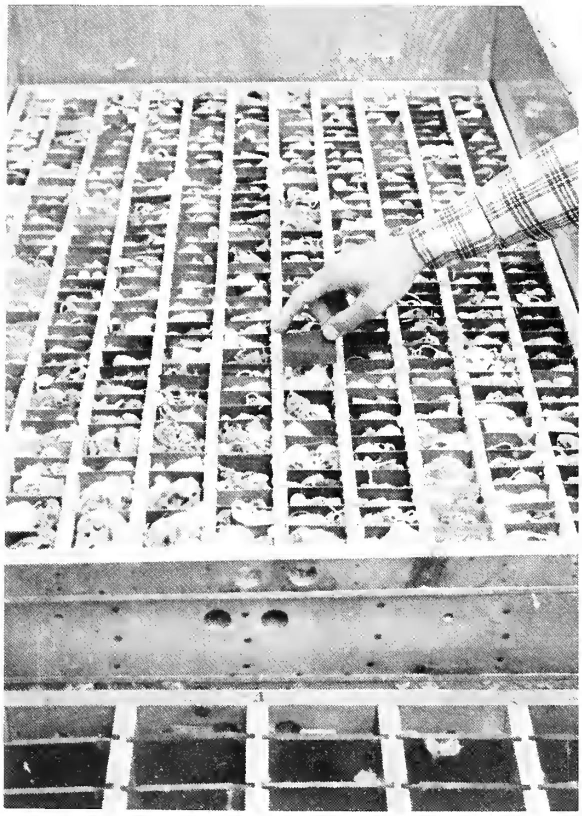


Fig. 18. Trays utilized in dermestid beetle colony, which in turn is used for cleaning of skeletal material. The individual dividers are removable, thus allowing alteration of the size of the individual compartments as necessary. At Texas Tech University three sizes of trays are used. Two of these are shown (note larger tray in foreground).

Although the dermestid may be very useful in osteological preparations, it is also a potential threat to Recent mammal collections because of the damage they can do to prepared skins. For this reason it is necessary that the dermestid colony be maintained in special facilities. Such facilities should include

humidity and temperature controls, and a box for the colony (Gennaro and Salb, 1972; Hall and Russell, 1933; Vorhies, 1948). This box should be resistant to insect damage and escape, and large enough to meet the needs of the collection. Because of specifications for effective maintenance and control of dermestid colonies, the use of commercial environmental chambers can provide ideal facilities. However, for further assurance, such facilities should be isolated, preferably in another building, from the mammal collection (Gennaro and Salb, 1972; Hall and Russell, 1933; Vorhies, 1948). Even these precautions do not guarantee the protection of the collection, and therefore, regular fumigation (see MAINTENANCE—Fumigation) is required.

FINAL PREPARATION: Following the basic cleaning, the skeletal material is processed through washing and scraping procedures to remove bloodstains, tendons, and other tissues not removed by previous processes. Skeletal material is first soaked in a solution of ammonium hydroxide (one part ammonia and three parts water) for 12 hours, followed by 24 hours of soaking in fresh water (Borell, 1939; Hall and Russell, 1933). For some specimens, particularly those having large bones, special degreasing procedures may be incorporated (Anderson, 1965; Finlayson, 1932; Martin, 1964; Sherman, 1925; Sommer and Anderson, 1974). Next, excess tissues remaining on the skeletal material are removed by hand through scraping and picking with dissecting instruments. Small amounts of remaining tissue and stains may be removed by placing the skeletal material in a diluted Clorox solution. Care should be taken to prevent soaking material too long or in excessive concentrations because skeletal material can rapidly deteriorate in such solutions. When the skeletal material is completely clean, it is dried and placed in appropriate containers (for example, vials and boxes) to prevent loss of parts. For further processing, the material may be placed in temporary storage and arranged in numerical order by collection catalog number to expedite retrieval and organization of subsequent processes.

To further insure against losing parts, all bones must be labeled with permanent black ink. If the size of the bone permits, the collection initials, collection catalog number, and sex should be included in the labeling. For ease in retrieval and installation, a label (see Processing Data—Labels) may be included in the container with the skeletal material (Fig. 19).

SPECIAL ITEMS

Special processing procedures of an acquisition will mainly depend on the diversity of material it includes. Some items may simply be installed in the appropriate storage facilities (see STORAGE). Other items may need to be processed by special techniques unique to the item in question. Such techniques would include taxidermy of specimens for exhibit purposes (Moyer, 1953), removal of skeletal material from scats or bird pellets (Giles, 1971), or clearing of embryos or anatomical parts (Hildebrand, 1968; Taylor, 1967*a*, 1967*b*). In some instances, special processing may require sending material, such as parasites, to a specialist. Whatever the item, reference to the literature or consultation with an expert is recommended to determine proper processing.

## INSTALLATION

The final stage of processing is reassociating all parts of the specimen in temporary storage. In most cases, this procedure will require only placing skeletal material with the corresponding skin. When all parts of the specimen have been centralized in temporary storage, the identification, data, and any other related information should be carefully checked for consistency and accuracy. If any problems exist, such specimens should remain in temporary storage until the situation is corrected.

Once a specimen, or preferably a group of specimens (for example, an accession), has been checked, it may be placed in the appropriate position in the research collection. This position is generally predetermined by the method of collection arrangement used by the institution (see PROCESSING—Organization and Arrangement). The arrangement of storage may, or may not, be the same as the arrangement used for cataloging procedures. In order to expedite installation and subsequent removal and replacement of specimens, it may be more convenient to arrange specimens of the same taxon and collecting locality in numerical order by collection catalog number (for example, TTU). This procedure will eliminate the need to include in the collection arrangement any extra data (for example, date, preparator, preparation number) which would otherwise complicate the arrangement.

The cases in the research collection and their corresponding drawers should be equipped with holders for labels that indicate the contents. Adequate expansion space should be incorporated throughout the storage facilities. Failure to do so may result in

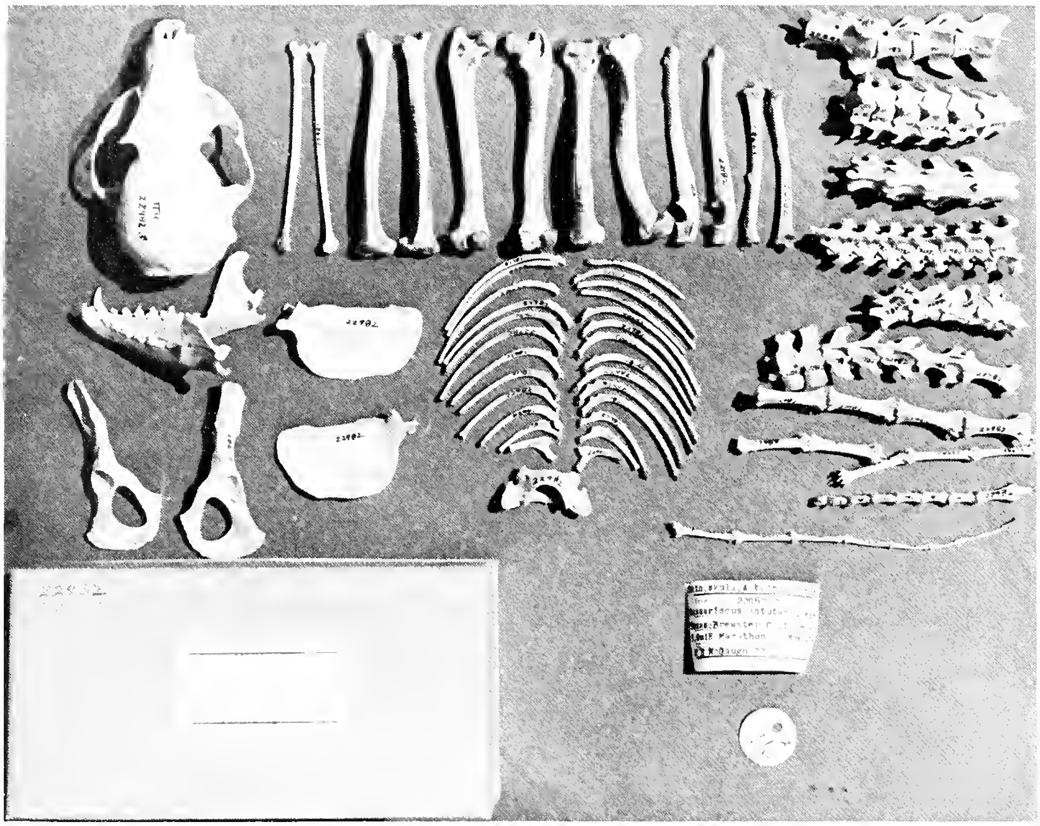


Fig. 19. Labeling of prepared skeletal material. Note the following: All bones of sufficient size are marked with at least the collection catalog number; original field tag is kept with specimen; a typed label is placed on top of the storage box; a typed label is placed inside the box.

reshuffling specimens each time a new acquisition is installed. If space permits, specimens of different taxa or different localities (for example, states) should be placed in separate drawers or separate trays within the drawers.

The placement and orientation of mammal specimens within drawers or trays (which are used to subdivide individual drawers) is determined primarily by their size, quantity, and the collection arrangement system used by the institution. Generally, specimens are arranged in drawers from front to back, starting on the left side with specimens lying perpendicular to the long axis of the drawer; or, from left to right, starting at the front with specimens lying parallel to the long axis of the drawer. If the quantity and size of the specimens justify the use of trays to subdivide the drawer, the arrangement within a tray will also be either from front to back or left to right. The sequence of trays within the drawer will depend on how the individual specimens are oriented. Containers (for example, vials and boxes) for skulls and postcranial material belonging to skins may be kept in smaller trays, designed for the purpose. Such containers are normally placed with the corresponding skins. Large skins and skulls can be stored parallel to the long axis of the drawer from left to right or perpendicular to the long axis of the drawer from front to rear (for example, USNM), or rear to front (for example, KU). Exceptionally large study skins may require diagonal placement within drawers.

Specimens consisting of only skeletal material may be installed with the skins and skulls or they may be placed at the end of the appropriate family (for example, TTU), genus (for example, KU), or species (for example, UCONN). Skeletal material removed from alcoholic specimens may be stored in the same manner or as a unit by itself (for example, TTU).

Fig. 20. Collection storage area for the Department of Mammalogy, The Museum of Texas Tech University. Note specimen storage cases, storage for fluid-preserved specimens, and hanging of large skulls on a screen rack in the background.

## STORAGE

Mammal specimens must be housed in a manner that will insure their continued existence in good condition. Utilization of storage areas imposes problems that include economical and practical allocation of space. Anderson (1973) suggests that $1.25 per square foot is a valid figure for the average cost of floor space for most collections. Storage areas and facilities must be reasonably fireproof, maintained at proper temperatures and relative humidities, protected from excessive sunlight and insect pests (American Society of Mammalogists, 1974), equipped with adequate lighting in both storage and work areas, and be well ventilated. Modern physical plants should contain a dependable air filtration/cooling system. Daily temperature fluctuations should not exceed 8.3°C (15°F) (Van Gelder, 1965). Hazardous substances must be kept away from specimen storage areas. Good security measures in general should be exercised.

The American Society of Mammalogists (1974) strongly urges institutions that are unable to provide minimal storage and maintenance standards, as defined by the Society, to transfer their holdings to an institution that is able to do so. Until a transfer can be conducted in such a situation, curators responsible for inactive collections may care for them with a minimal expenditure of time and money, as suggested by Van Gelder (1965).

Specimens must be shielded from the damaging effects of light. The ultraviolet and the bluish portions of the visible spectrum have the greatest ability to stimulate chemical change. It should be noted that a 5.5°C (10°F) rise in temperature can double the rate of photochemical activity (Stolow, 1966). Although less potent than daylight, incadescent and fluorescent lamplight does contain ultraviolet components. The far more desirable fluorescent lamps can be fitted with acrylic filters that nearly eliminate the deleterious wavelengths, while not appreciably altering the rest of the spectrum (Stolow, 1966).

Storage facilities must also protect specimens from dust and atmospheric pollutants. Sulphur dioxide, for example, causes leather to become brittle. Mold, an additional threat to collections, may begin to form at a relative humidity of 80% or above and at a minimum temperature of 20°C (68°F).

Ideally, the entire collection should be on the same floor with offices and laboratories (an exception being the dermestid colony). All pertinent data and records associated with the specimens should be near the collection. In most cases, the largest allocation of floor space will be for specimen storage (Fig. 20). Ample work space should also be available. Curatorial and supporting staff offices, library space, laboratory, and equipment/supply storage areas are vital and should be included in all Recent mammal collection facilities (Fig. 21).

Fig. 21. Equipment storage area for the Department of Mammalogy, The Museum of Texas Tech University.

Mammal specimens and their associated data are prepared in a variety of ways. It is advisable, wherever possible, to position all parts of a specimen prepared in the same way in close proximity to facilitate utilization. Each type of storage requires ingenuity and has characteristics and problems at least partially unique to it, as described below.

## SKIN AND SKELETAL MATERIAL

Small and medium size mammal specimens, classically consisting of a rounded study skin and accompanying skull, normally constitute the largest percentage of a collection's holdings. More recently though, postcranial material has been collected and preserved in increasing quantities.

Specimens preserved as skin and skeletal material should be protectively housed in permanent storage cabinets or cases (Fig. 22) that are essentially air-tight to exclude light, dust, and insect pests, and to retard loss of fumigant. Cases may be constructed entirely of wood, metal, or a combination of both. Metal cases provide the greatest protection from fire. Several manufacturers produce cabinets of various dimensions that meet museum specifications (Dowler and Genoways, 1976). Knudsen (1966) gives instructions for the construction of a "suitable and inexpensive" wooden storage case. While affording security to their contents, permanent storage cabinets should also be of modular construction, to allow for maximum flexibility of use. Cases should not be so massive as to be virtually immovable. A white cabinet exterior has the dual advantage of reflecting more light for better visibility as well as helping to maintain lower temperatures within the case.

The specimens themselves rest in wooden, wood-masonite, or metal-masonite drawers (Fig. 23). The storage cases are equipped with metal or hardwood guides for accommodating drawers. The hardwood runners of the wooden drawers usually require waxing. Specimens are usually placed in pasteboard trays available in various modular dimensions (Dowler and Genoways, 1976). These "paper" trays are recommended for use wherever specimen size permits. They provide a clean, white, splinter-free surface for specimens and allow removal of several mammals at a time, while enabling a subdivision of the large drawers into more convenient size units. The standard size museum case may hold approximately 300 specimens of average size (300 mm total length). When single-stacked, the case tops become convenient layout space. When double-stacked, they allow for a doubling of the storage space on the same floor area. They should be arranged in banks, back to back, creating accessibility to cases on both sides of the aisle, and spaced so as to permit easy tray removal and replacement.

Glass or plastic vials of various sizes (Fig. 24) can be used for storing skeletal material (Dowler and Genoways, 1976; Long, 1970). Glass vials are relatively expensive and break more easily than plastic vials. Plastic vials scratch, crack, discolor, or cloud in the presence of certain fumigants (see MAINTENANCE—Fumigation), are flammable and hence, have a shorter life span. These negative properties may outweigh the initial savings gained by their lower cost.

Stoppers made of various plastics and of different design can be used. These are generally much better than the cork stoppers, which become brittle and may break with age. Stoppers should create an air-tight seal, yet be easily removable. Snap-cap lids are not as desirable because their rim does not allow for level placement of the vial on its side. In addition to

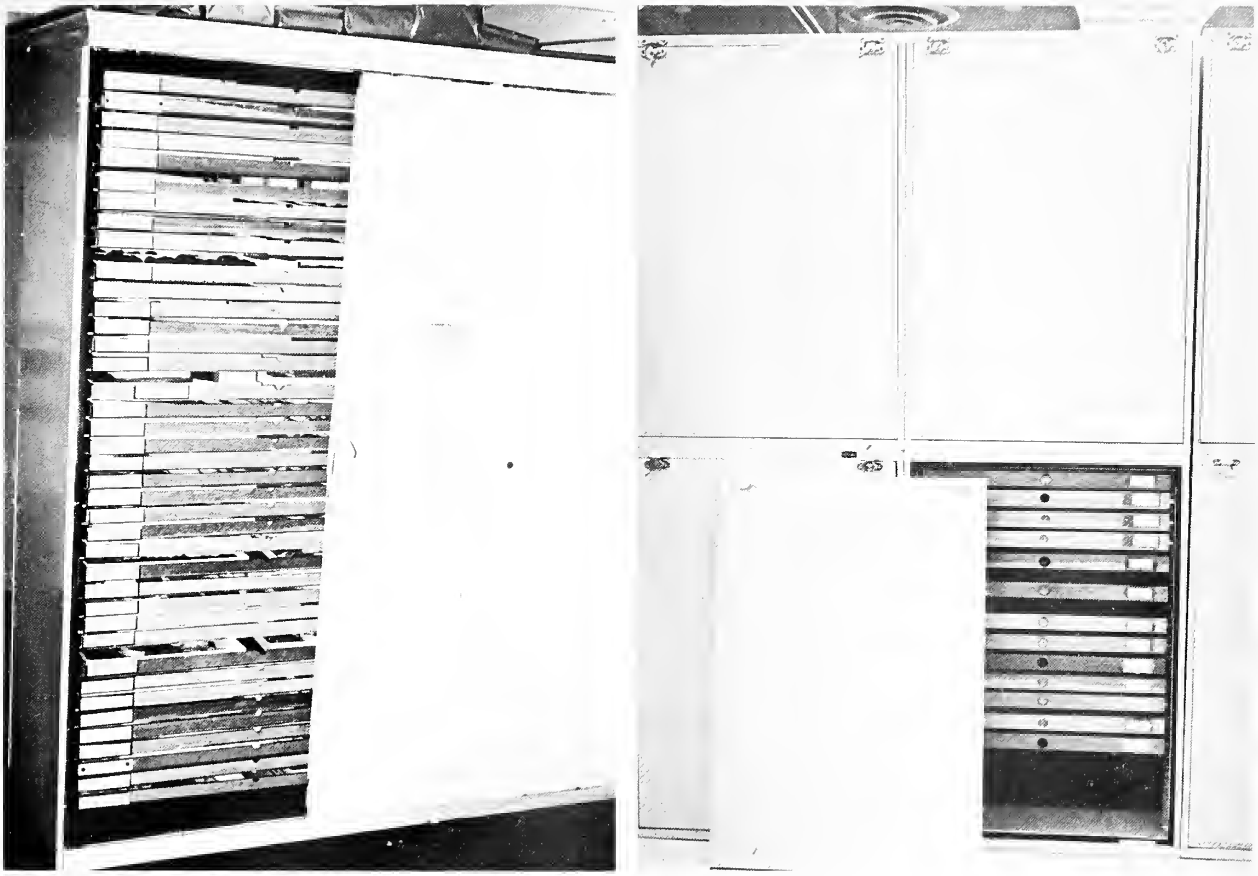


Fig. 22. Specimen storage cases of two types. Numerous other construction types are available. Left, Department of Mammalogy, American Museum of Natural History; right, Department of Mammalogy, The Museum of Texas Tech University (purchased from Steel Fixture Co.).

these types of lids, metal caps are occasionally used.

Boxes of various kinds (Fig. 24) are also available for skeletal material that is too large for vials. Ideally, they should be of a modular nature allowing for most efficient use of space within case drawers. All skeletal material should be placed in containers that are neither too small nor too large for them.

Certain specimens may require a different orientation, than previously described (see PROCESSING—Installation), within trays and drawers in order to avoid injury. Animals with bushy tails, long ears, vibrissae and the like, must be stored carefully to prevent their destruction through overcrowding. Drawers must be spaced in a way that will prevent damage to the specimens underneath.

Specimens consisting only of skeletal material or skeletal material removed from specimens preserved in alcohol may have labels that are marked or color-coded (for example, blue for skeletal material only, or yellow for skeletal material removed from alcoholics). This procedure can facilitate ease in handling and utilization. Further ease in handling may be possible by storing such material separately, as opposed to mixing it with specimens consisting of skins and skeletal material (see PROCESSING—Installation).

Tanned hides pose storage problems different from those encountered with study skins. The large, long-established collections have traditionally kept tanned hides in refrigerated "fur vaults" (Fig. 25). Usually the hides are hung from horizontal pipes. An S-shaped hook passes over the bar supporting the skins by means of a stout cord attached to the specimen. The cord usually passes through the eye holes or nostrils. These vaults are equipped with temperature and relative-humidity control systems that should maintain a temperature of approximately 4.4° to 7.1°C (40° to 45°F) and a relative humidity of

Fig. 23. Arrangement of specimens in a storage drawer (front of drawer to the left). Note that different taxa are placed in separate specimen trays, and that internal room for expansion of the collection is provided. The first specimen in the drawer is in the upper left-hand corner. Specimens are arranged from front to back in each row of trays.

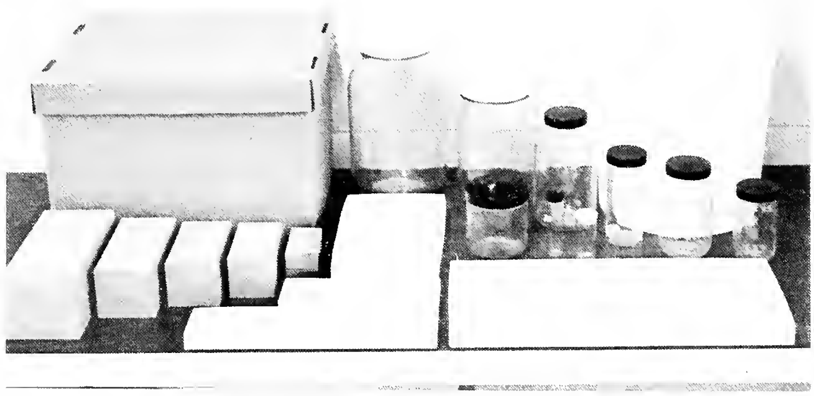


Fig. 24. Curatorial supplies used for the storage of specimens in the Recent mammal collection at Texas Tech University. Included in the photograph are skeleton storage boxes, specimen and skull trays, container for fluid-preserved specimens and vials for skulls and skeletons (see Dowler and Genoways, 1976, for specifications of these items).

Fig. 25. Method of storage of tanned skins in a fur vault. Note technique for hanging the skins. This photograph was taken in the Museum of Natural History, University of Kansas.

approximately 50 to 55%. To guard against fires, a sprinkler system is a necessity in this type of potentially hazardous storage situation. Periodic fumigation is a required precaution as well. Specimen arrangement within fur vaults might be a taxonomic, geographic, size, or a combination system depending on the size of the collection and the dimensions of the storage chamber.

Dr. Henry W. Setzer (personal communication) of the National Museum of Natural History feels that fur vaults are no longer necessary where proper air-conditioning and humidity controls exist. He cites the uneconomical nature of vaults, security problems, and inefficient storage capabilities as reasons for their elimination. Furthermore, large skins often develop tears at the point of support as a consequence of their great weight. Setzer finds case storage of tanned hides to be an acceptable alternative. Hides should be loosely rolled and tied with the tags exposed. If cases are not available, then hides may be placed in boxes or plastic bags, and stored in a cool, dry, dark place. Care should always be taken to avoid rolling the hides too tightly.

Untanned hides that are thoroughly dry should be stored in plastic and heavily fumigated (Van Gelder, 1965). Raw hides are sometimes held in cold-storage facilities prior to tanning.

Generally, skeletal material is easier to house than skins. Deterioration from over-exposure to sunlight and danger from insect infestations do not present major problems for such materials. Rapid temperature fluctuations, dessication, and dust are the chief causes of concern to osteological collections. Jackson (1926) mentioned 21°C (70°F) as being a proper temperature for housing such material. Dudley and Wilkinson (1968) recommended a constant relative humidity of at least 55% for ivory. Large skulls or disarticulated postcranial skeletons are best housed in kraft boxes within air-tight cabinets, in cardboard boxes, or simply in deep wooden drawers inside

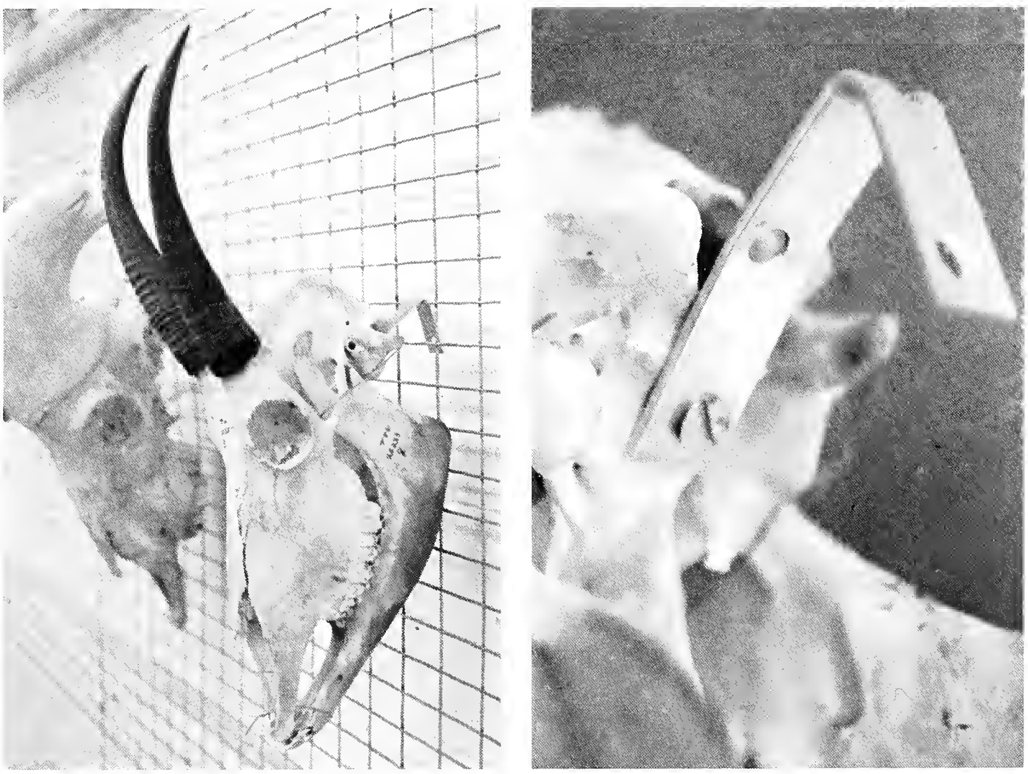


Fig. 26. Storage of large skulls by suspending them from screen racks. Photograph on the left shows skull in place on the rack. Photograph on the right illustrates how the bracket, used for hanging the skull, is attached. This method of storage is used at the University of Kansas and Texas Tech University.

Fig. 27. Storage of large skulls by suspending them, by the base of the antlers or horns, between two parallel horizontal rods. Photograph taken at the University of Montana.

museum cases. Additionally, large heavy skeletons may be conveniently stored in small wooden rolling cases. Boxes containing specimens may be placed on tops of double-stacked cases if more suitable accommodations are not available. The smallest osteological elements of a specimen should be placed in vials or boxes within the larger containers. Vertebrae may be conveniently strung in proper order to avoid loss and to facilitate retrieval. Hollister (1923) described a special treatment that might be accorded incisor teeth of ruminants. Many mammal collections (for example, KU and TTU) suspend their large skulls from a vertical wire screen positioned against a wall. Skulls are supported by means of a U-shaped metal brace bolted to them just below the foramen magnum (Fig. 26). Corresponding postcranial material, if present, is stored elsewhere. Although the hanging of large skulls does solve space problems, such material inadvertently becomes exposed to mechanical damage and dust. Jackson (1926) suggested suspending large horned and antlered skulls horizontally between two parallel rods, supporting the skulls at the horn or antler bases (Fig. 27). Rather inexpensive storage racks of perforated structural steel and ordinary wooden planking (Colbert, 1961) are also strong and highly adaptable storage facilities for large skeletal material (Fig. 28). A disadvantage is that the lack of drawers does not allow easy access. Dust and security problems may also be encountered. A system in which osteological material is stored within fiberglass tote boxes on wooden shelves is described by Lewis and Redfield (1970). These boxes, with lids, originally used on assembly lines in factories, may be stacked inside one another when empty. Each shelf unit holds 20 such boxes. An alternative method of storing exceptionally large skeletons (for example, cetaceans) is to mount such specimens for display purposes (Fig. 29).

Fig. 28. Storage of large skulls and skeletons by placing them on wooden shelving. Photograph taken at the University of Montana.

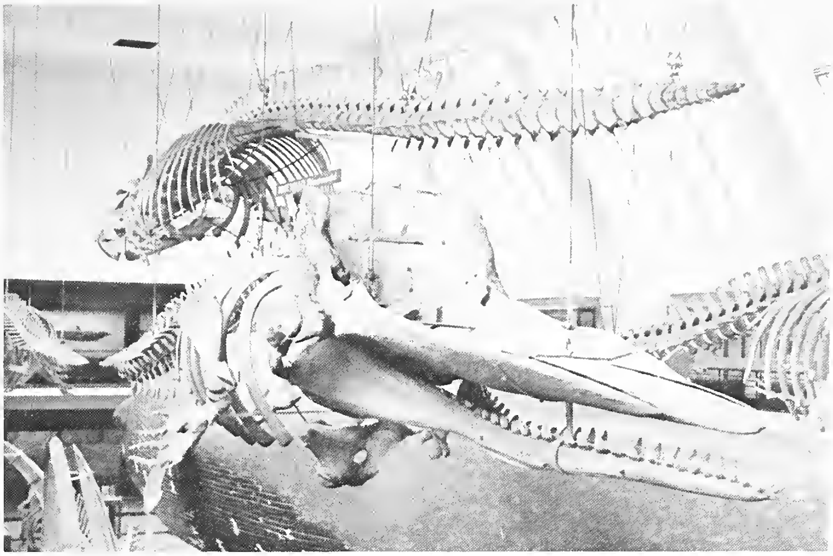


Fig. 29. Mounting specimens for display is one method of storing skeletons, particularly exceptionally large ones. These cetacean skeletons are on exhibit at the British Museum (Natural History).

Uncleaned osteological specimens must be kept dry and protected from insect attack. Unprocessed material should not be stored in airtight containers, because this may result in mildew or decay. The addition of a dessicant or fungicide (for example, thymol crystals or silica gel) may be necessary if mildew is a problem.

## FLUID-PRESERVED MATERIAL

Specimens preserved in alcohol and other preservatives may be stored in vessels of various sizes, shapes, and descriptions (Fig. 24). Perhaps the best glass jars for small and medium-size mammals are the wide-mouth variety, equipped with rubber washers and glass lids held firmly in place by wire bails. These jars are becoming more difficult to obtain. Glass Mason or Ball jars, which have a two-piece metal lid, have also received extensive collection use (Palmer, 1974). Currently, the most commonly used glass jar is probably the wide-mouth variety with a bakelite lid (for example, UCONN, MHP, TTU, and UPS). The lids, which may be purchased separately, can be fitted with polyethylene rather than vinyl-coated paper liners. Polyethylene lids are also available for glass jars. Cork and neoprene rubber stoppers should never be used to cap vials containing alcohol. Both will react chemically with the preservative, lowering its pH as well as darkening the solution (Levi, 1966).

Specimens stored in fluid may be housed in steel cabinets with hinged doors or placed on metal shelving (Colbert, 1961). Removable safety guards may be attached to the front of the shelf. Alcoholic specimens are particularly sensitive to sunlight and should be stored in dark places. A method of possibly preventing color changes would be the use of butyl hydroxytoluene in formalin solutions (White and Peters, 1969). The Royal Ontario Museum reports the use of "light-proof" curtains to shield their specimens located on metal shelving. A separate fireproof, windowless room designed for storage of alcoholic specimens is ideal. Jars should be protected from excessive heat. Local regulations concerning fire prevention should be consulted. Jackson (1926) suggested the maintenance of 21°C (70°F) for storage of specimens in alcohol.

Specimens should not be crowded into the storage vessels. Usually the volume of preservative should be twice the volume of the specimens (Zweifel, 1966). Specimens too large to fit into the largest glass jars can be housed in metal (stainless steel) tanks, plastic carboys, concrete vats, or earthenware crocks. Stainless steel tanks fitted with dollies and casters are ideal, but expensive. The tank lids with their snap fasteners and neoprene gaskets produce the required tight seal. An inexpensive method of manufacturing large storage tanks of plywood,

Fig. 30. A portion of the fluid-preserved specimens at the National Museum of Natural History. This collection is arranged by size of containers rather than systematically. Each shelf position is numbered (note on upper shelf), and a card file is kept for recording the position of each specimen.

lined with polyester resins, has been described by Dundee (1962).

Embryological and anatomical materials are sometimes stored separately. More often they are housed with the main collection of alcoholic specimens.

Some institutions (for example, ROM, USNM, MVZ, FSM, KU, and UPS) maintain holdings of digestive tracts and their contents. By using 2.5% to 10% solutions of buffered formalin (Martin, 1949; Quay, 1974), or perhaps freezing facilities (for example, WFBM), such material may be stored near the main fluid-preserved collection, but it is usually housed separately in phylogenetic arrangement. Storage of frozen material is discussed below.

Cleared and stained glandes are stored in vials of glycerine. The addition of a few crystals of thymol to the glycerine helps prevent mold growth (Taylor, 1967*a*, 1967*b*). Glandes may be kept with the bacula (if those are housed separately), fluid-preserved holdings, or by themselves.

Fluid-preserved material may be arranged phylogenetically to the subfamily, generic, or species level and then perhaps alphabetically. Such material is stored separately—not with the remainder of the collection. If it is not feasible, do not arrange jars numerically by collection catalog number but rather by jar size within taxa. At the National Museum of Natural History, jars are arranged on shelves according to size without regard to taxon (Fig. 30). Each jar is assigned a specific shelf location based on this criterion. A phylogenetic cardfile giving the location of each specimen is maintained. Advantages of this system include better utilization of space and the elimination of reshuffling as new material is incorporated. However, retrieval of specimens belonging to any given taxon may be rather time-consuming. The maintenance of a specimen cardfile likewise requires substantial staff time.

Alcohol levels may be readily discerned if larger vessels are placed behind smaller ones. Metal tanks, crocks, and carboys should be kept under counters, and in cool places, where they will not impede movement of workers.

## SPECIAL ITEMS

### TYPE SPECIMENS

Type specimens are certainly among the most valuable holdings of any collection of Recent mammals. It is stressed that institutions lacking the proper storage facilities, and having small collections that are infrequently visited by professionals, make arrangements to deposit their type specimens with large and responsible collections (American Society of Mammalogists, 1974; Baker, 1970).

Nearly every institution houses its holotypes in special units, such as safes (for example, UWZM), locking cabinets (for example, MVZ, KU, and UPS), or other storage units removed from the regular collection (for example, TCWC). Traditionally, holotypes have had special, often red, vial/box labels and skin tags (Fig. 31). Drawer and case labels sometimes are also marked with red labels (Fig. 32). Holotypes preserved in alcohol also have special notation and are stored apart from the remainder of the alcoholic collection. Type specimens are normally arranged phylogenetically. Study skins are occasionally enclosed in plastic to provide added protection (for example, UPS). Type specimens are stored in separate pasteboard trays at some collections (for example, USNM).

Some collections (for example, ROM and TCWC) store the original published descriptions with their holotype specimens. It is wise to provide at least the skin tag and the museum catalog number with a notation as to the author of the description and the journal and year in which it was published.

The Department of Mammalogy at The Royal Ontario Museum follows rather extensive documenting procedures with its type holdings. Black and white prints are made of the skull, and color transparencies are made of the skin. Skulls are usually extracted from alcoholic types and dried temporarily for photographing. Usually, drawings of soft palate and facial regions are made as well.

### TEACHING COLLECTIONS

Many collections, especially those affiliated with universities, maintain a separate cataloged or uncataloged mammal collection for use in the classroom. These specimens must endure a great deal of use and abuse and hence must be of an expendable nature. Research specimens should not be loaned for teaching or exhibition purposes under normal circumstances. Mammal specimens lacking data, while worthless for research, may be valuable additions to a teaching collection. These specimens should be clearly marked as to their nature. Such collections should be housed and cared for in the same manner as the research holdings.

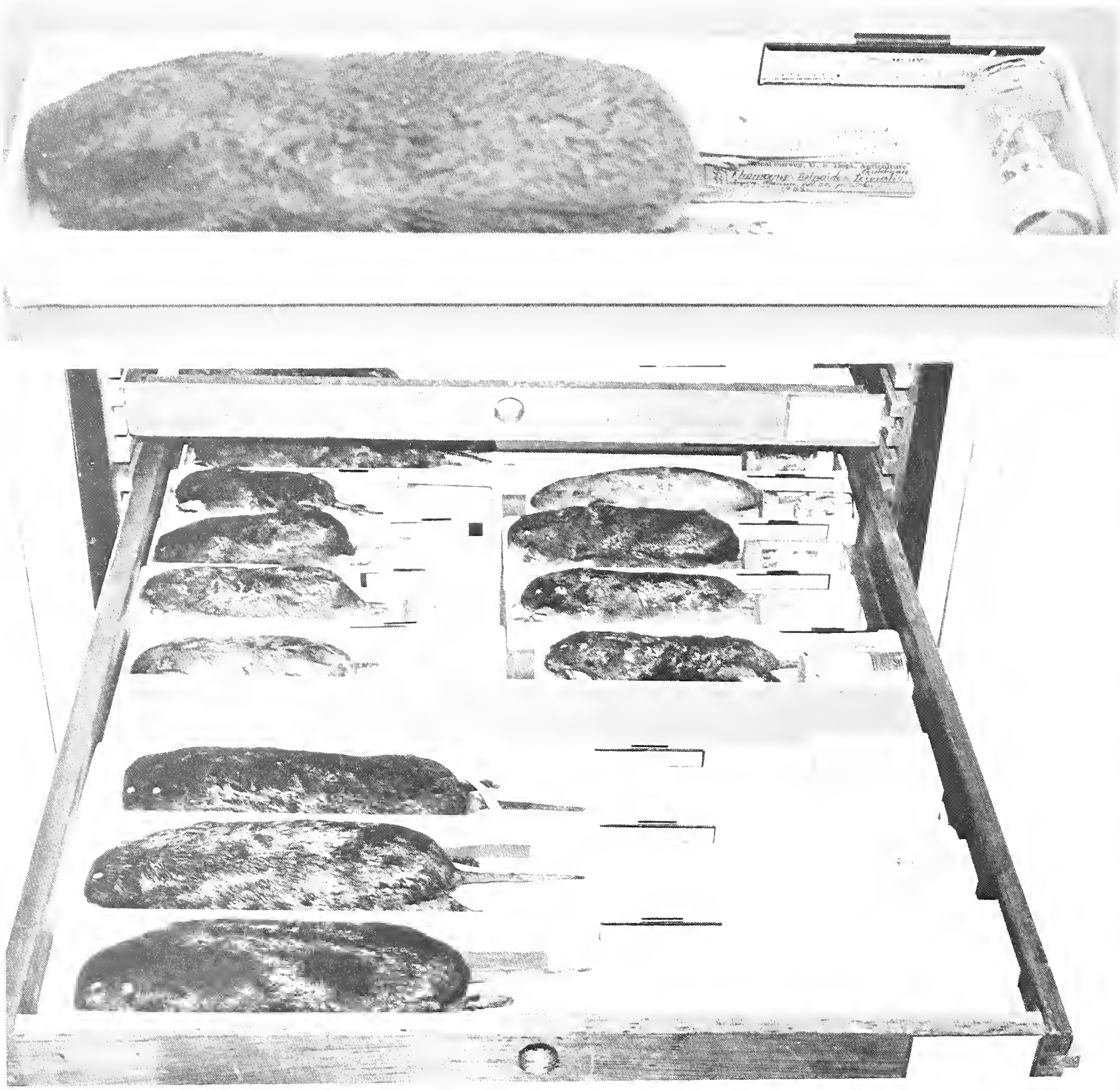


Fig. 31. Arrangement of holotypes at the National Museum of Natural History. Upper, holotype of *Thomomys talpoides trivialis* positioned in its individual specimen tray; lower, holotypes of pocket gophers as they are arranged in their specimen-storage-case drawer. All holotypes have supplementary red holotype labels.

Fig. 32. A portion of the holotype collection at the National Museum of Natural History. Cases containing holotypes are marked with red labels.

If limited teaching material results in a heavy reliance on the research collection, it is suggested that the teaching collection be equipped with casts and models of the needed skeletal material. Several techniques have been described that can provide high-quality material for teaching purposes (Long, 1970; Madsen, 1974; Schrimper, 1973; Waters and Savage, 1971). This technique for building a teaching collection will produce more durable specimens; allow easy and comparatively less expensive replacement of specimens (assuming the original mold or cast is saved); allow as many replicas as needed; encourage the learning of valid taxonomic characters, instead of extraneous features unique to the individual specimen (for example, broken bones, missing teeth, or foreign markings); and, allow incorporation of rare and endangered species (for example, *Euderma maculatum, Mustela nigripes,* and *Enhydra lutris*) and other protected or hard-to-obtain species (for example, *Ornithorhynchus, Tachyglossus,* and *Zaglossus*).

## DOMESTIC MAMMALS

In addition to the special collections outlined above, some institutions maintain domestic mammal collections as separate entities for purposes of research, reference material, or educational/exhibitional purposes. These specimens receive the same treatment as those in the regular collections. More often, domestic mammals are housed among the regular collections and accorded no special treatment.

## WHOLE MOUNTS AND TROPHY HEADS

Whole mounts and trophy heads, temporarily or permanently removed from display, again present some unique storage challenges. Sometimes these

mounts are cataloged specimens and may even be of great scientific as well as educational value. One shold be aware that museum catalog numbers and other data may be attached to the underside of the pedestal or plaque on which the mount rests. Whole mounts can be stroed on shelves, in cases or in boxes, size permitting. Such specimens must also be shielded from light, dust, and insect attack. Black plastic sheeting can be draped over free-standing mounts. Mounted trophy heads with large antlers, horns, or tusks represent one of the most difficult storage situations to a collection of Recent mammals. They may be stored in large cabinets (which results in a waste of space) or they may simply be laid on shelves or hung from walls and draped with plastic. Mounted mammal specimens, if few in number, may not warrant phylogenetic arrangement and may be segregated from related taxa because of sheer size.

Articulated and mounted skeletal material (for example, whole mounts) require similar storage considerations. They may be housed in cardboard boxes or stored in cabinets, depending upon their size.

## SPECIAL OSTEOLOGICAL COLLECTIONS

Special osteological material, such as bacula, hyoid apparati, or ear ossicles, are normally stored with the use of skull boxes, vials, insect pins (Friley, 1947), or microscope slides (White, 1951), depending primarily upon size and nature of the item. Although some collections maintain separate storage facilities for special osteological holdings, such materials are often stored with corresponding skeletal material. When stored alone, they are best arranged phylogenetically. When stored with the skeletal material, they may simply be loose within the container, or still better, kept in tiny insect "genitalia vials" or gelatin capsules (Dowler and Genoways, 1976). Colored capsules are more readily located than are clear ones. The major disadvantage of gelatin capsules is their tendency to fuse under hot, humid conditions.

## MICROSCOPE SLIDES

While various types of material lend themselves to preparation as microscope mounts (for example, bacula, hairs, tissue sections, blood smears, sperm, and karyotypes), such preparations are subject to damage by light and by temperature fluctuations.

Storage of microscope slides (Fig. 33) is governed by the type of preparation. Slides may be stored vertically or flat in plastic or wooden slide boxes having a capacity of 12 to 100 slides, or in specially designed cabinets having a capacity of 400 to 1600 slides.

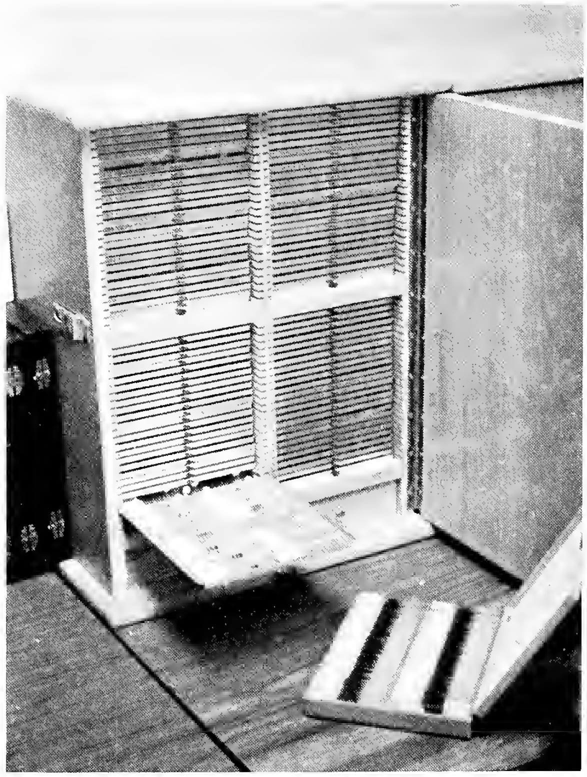


Fig. 33. Two types of storage units for slides. The unit in the foreground will hold 100 slides stored vertically. The unit in the background will hold 1600 slides stored horizontally.

These modular units of wood with aluminum drawers may be conveniently stacked and placed on shelves. Utilization of any particular storage unit will depend primarily on the nature of the preparation.

Slide collections can be arranged phylogenetically, numerically by acquisition, or in any other way that circumstances require. At Texas Tech University, a special slide collection for cytological material is maintained. Because the collection is very extensive and used continuously, special numbers and catalogs (Fig. 34) are used for ease in processing and use. Each specimen used for cytological preparations receives a sequential number from the catalog. This number is cross-referenced with the preparation number and collection catalog number in the respective catalogs.

## FROZEN MATERIALS

Collections of living mammalian cells are still in preliminary stages of development. The Univeristy of Texas and Texas Tech University maintain a collection of frozen living cells. Curatorial techniques are presently being formulated at Texas Tech University. At present, cultures are stored in plastic vials with

Karyotyped by J. W. Bickham Date 19 Sept 1974 **TK 7591**
Collector S. L. Williams Date 19 Sept 1974
Preparator S. L. Williams Number 1812

TT 26377

Sex: ♂ Species: Lasionycteris noctivagans
State: Texas County: Lubbock
Specific locale: Lubbock

Mitotic Meiotic Special Staining

| | Coordinates | 2N | No. Biarm | No. Acro | Photo No. | Comments |
|---|---|---|---|---|---|---|
| 1 | 27.3 X 113.5 | 20 | | | F 2152 | G-Band |
| 2 | 22.5 X 103.1 | 20 | | | F 2153 | " |
| 3 | 35.8 X 119.3 | 20 | | | F 2154 | " |
| 4 | X | | | | | |
| 5 | X | | | | | |
| 6 | X | | | | | |
| 7 | X | | | | | |
| 8 | X | | | | | |
| 9 | X | | | | | |
| 10 | X | | | | | |

Remarks:
Tissue culture
3 ear frozen 4 Oct 1974
1 ear frozen 7 Oct 1974

Fig. 34. Page from catalog used for recording data on specimens that have been karyotyped and tissue-cultured at Texas Tech University. This catalog, designed by Robert J. Baker, has consecutively numbered pages in a bound volume. Original page size was 225 by 150 millimeters.

plastic screw caps within liquid nitrogen freezer units at approximately -195°C (-320°F). The vials can be kept within stationary or portable units which have a capacity of approximately 200 cell cultures. A numerical (by collection catalog number) or phylogenetic arrangement of samples may be used for storage.

Entire mammals or non-living tissues may be stored in a frozen state at -76°C (-105°F) for enzymatic analysis, as is done at the Univeristy of California, Berkeley (Lidicker *et al.*, 1974).

### CASTS AND REPLICAS

Plastic and plaster casts of entire skulls, skeletal elements, toothrows, and tracks, and latex brain endocasts are occasionally found in collections of Recent mammals. Fragile plaster casts, like osteological specimens, must be protected from rapid temperature variations and mechanical damage. They may be laid in boxes or trays lined with cotton (Van Gelder, 1965), and arranged phylogenetically, numerically, or be size.

### MISCELLANEOUS

Parasites removed from mammal specimens (for example, in the course of field studies) are normally stored in alcohol or mounted on microscope slides. They are often sent to specialists outside the institution or deposited with the appropriate collection of the home institution. Specimens in vials are treated in a similar manner as other fluid-preserved material.

Items such as scats, pellets, and cheek-pouch contents may be present in collection holdings. Such items may be stored separately, contained in vials, skull boxes, and the like, and arranged taxonomically, numerically (by collection catalog number), or by size. They may be stored in the dry state indefinitely, but must be fumigated periodically. Murie (1954) stated that a liberal coating of Ambroid Cement or glue varnish, applied with a brush, serves to protect scats from insects as well as helping to maintain their shape. Other types of coatings, such as spray or brush-on acrylics and other plastics, have also been successfully used (for example, UPS). These forms of protection may also help to repel moisture. As an alternative, such materials may be kept in weak solutions of buffered formalin.

Permanent scanning-electron-microscope mounts may be attached to the underside of a plastic vial stopper with an adhesive. Because the stopper is in a vial stored in an inverted position, the mount is safe from dust and mechanical damage.

## DOCUMENTS

### WRITTEN RECORDS

Written records in the form of collector's field notes and catalogs, specimen data sheets, collection catalogs, card files, accession records, permits, and pertinent correspondence are immensely valuable, and enhance specimen value enormously. A specimen without proper data is virtually worthless for research purposes.

Excessive moisture, dryness, insects, and strong sunlight are potential threats to paper. A moderate amount of sunlight, however, is helpful in preventing mold growth (Dice, 1925). Thymol crystals may likewise inhibit mold growth (Anon., 1962; Duckett, 1975). Proper air-conditioning will also help prevent damage by fungus (Duckett, 1975). Relative humidity should not exceed 50% and temperatures should not exceed 21°C (71°F) in paper storage areas (Duckett, 1975; Dudley and Wilkinson, 1968). All paper should be stored in acid-free-paper storage boxes (USNM). One of the most popular containers for archival storage is the "Hollinger carton" (source - Hollinger Corporation, 3810 S. Four Mile Run Dr., Arlington, Virginia 22206). For more information on this carton and the proper care of documents refer to Duckett (1975).

Library materials are best stored in wooden cabinets, or on wooden shelves, provided with glass fronts as protection from dust, especially when the building lacks air-conditioning. Van Gelder (1965) recommends that all valuable data be duplicated and that the originals be stored elsewhere, preferably in a fireproof safe. The duplicates are then available for everyday usage. Publications that exceed 150 pages, and field notes should be permanently bound. Smaller pamphlets and reprints are commonly stored in inexpensive, open-backed reprint boxes and shelves. Dice (1925) strongly recommended that thin papers be protected by a cover of heavy cardboard. They may also be stored in filing cabinets, within cardboard covers, or even in manila envelopes if better facilities are lacking. All containers of library materials should be clearly marked and stored near specimens to facilitate use. To provide the library facilities described, Anderson (1973) suggests that the cost of library maintenance be $0.125 per volume

per year. For more information regarding storage problems and solutions see Storer (1916).

Collection catalogs are arranged numerically. Field notes are bound chronologically for a given collector and arranged alphabetically according to the collector's surname. Books and reprints are most conveniently stored alphabetically by author, or by first author only (if there is more than one author), and chronologically if there are several publications by the same author. Some small, non-research collections may wish to arrange their libraries by subject headings rather than by author.

MAPS

Maps and drawings are properly filed flat in specially designed map cases. Maps may be arranged alphabetically or geographically. Each drawer should be properly labeled. Partitions in drawers allow easy removal and replacement of maps, and provide subdivisions, labeling, and limited protection for series of maps.

PHOTOGRAPHIC ITEMS

Photographic materials require various arrangements, storage facilities, and care, depending upon their nature. All must be protected from excessive heat, moisture, and light. Prints, negatives, color transparencies, lantern slides, motion-picture films, X-rays, and microfilms should be stored in appropriate containers and labeled. Prints, if stored vertically, must be mounted on poster board, but this can be expensive and time-consuming (Vanderbilt, 1966). Mounting can be avoided when the prints are stored flat. Prints and other photographic surfaces should not be allowed to come into contact with papers that contain residual sulphur. Paper for file usage should have a pH above 5.0 and should not contain more than 0.0008% residual sulphur (Vanderbilt, 1966). Negatives can be housed in file boxes within paper jackets. Each strip should be in a separate jacket. Color transparencies may be kept in slide boxes and cabinets of different capacities. Motion-picture film reels are best stored in dry metal canisters at low temperatures to avoid distortion and shrinkage of the film. The old nitrate-based films require separate storage and periodic inspection because of their high degree of flammability (Burns and Root, 1975). Organization of photographic data may be determined by nature and size of material, subject, or chronology.

TAPES

A few institutions (for example, MVZ, KU, and UWZM) maintain collections of recorded mammal vocalizations and the like. Such tapes may be stored in original containers and arranged phylogenetically or by other schemes. They should be housed in accordance with the instructions of the manufacturer and protected from heat, dust, and demagnetizing sources.

## MAINTENANCE

Mammal specimens and other collection objects may suffer damage or deterioration from many sources, including fire, water, dust, atmospheric pollutants, extreme temperatures, excessive fluctuations in temperature and atmospheric moisture, dessication, direct sunlight, careless handling, accidents, and pests. Collections must be properly housed and diligently cared for, to insure their continued existence and integrity. Such maintenance will cost Recent mammal collections approximately $0.12 per specimen per year for building maintenance alone (American Society of Mammalogists, 1974). If other maintenance costs and procedures are included, such as fumigation, special care of tanned hides, degreasing specimens, fluid replenishment, specimen repair, replacement of expendable items, collection rearrangement, updating taxonomic revisions, salaries, and other processes, the cost of maintenance is at least doubled. Therefore, an institution might expect to pay a minimum of $0.24 per specimen per year. This expense is based on small specimens. Larger specimens would, of course, cost more (Anderson, 1973). Because of the time and expense involved, proper maintenance procedures (Fig. 35) must be considered essential to collection management.

Many maintenance problems can be avoided by preventive measures. For instance, several things can be done during the initial preparation of the study specimens that may obviate the necessity of later maintenance. Avoiding overstuffed bodies and protruding appendages or pinnae can prevent repairs of torn or broken parts. Proper cleaning of the skin can avoid the need for degreasing. In some instances, it is possible to provide physical support for the specimen. For example, the use of a stick in preparing rabbits (Anderson, 1965) offers a means of support, handling, and protection for the back legs.

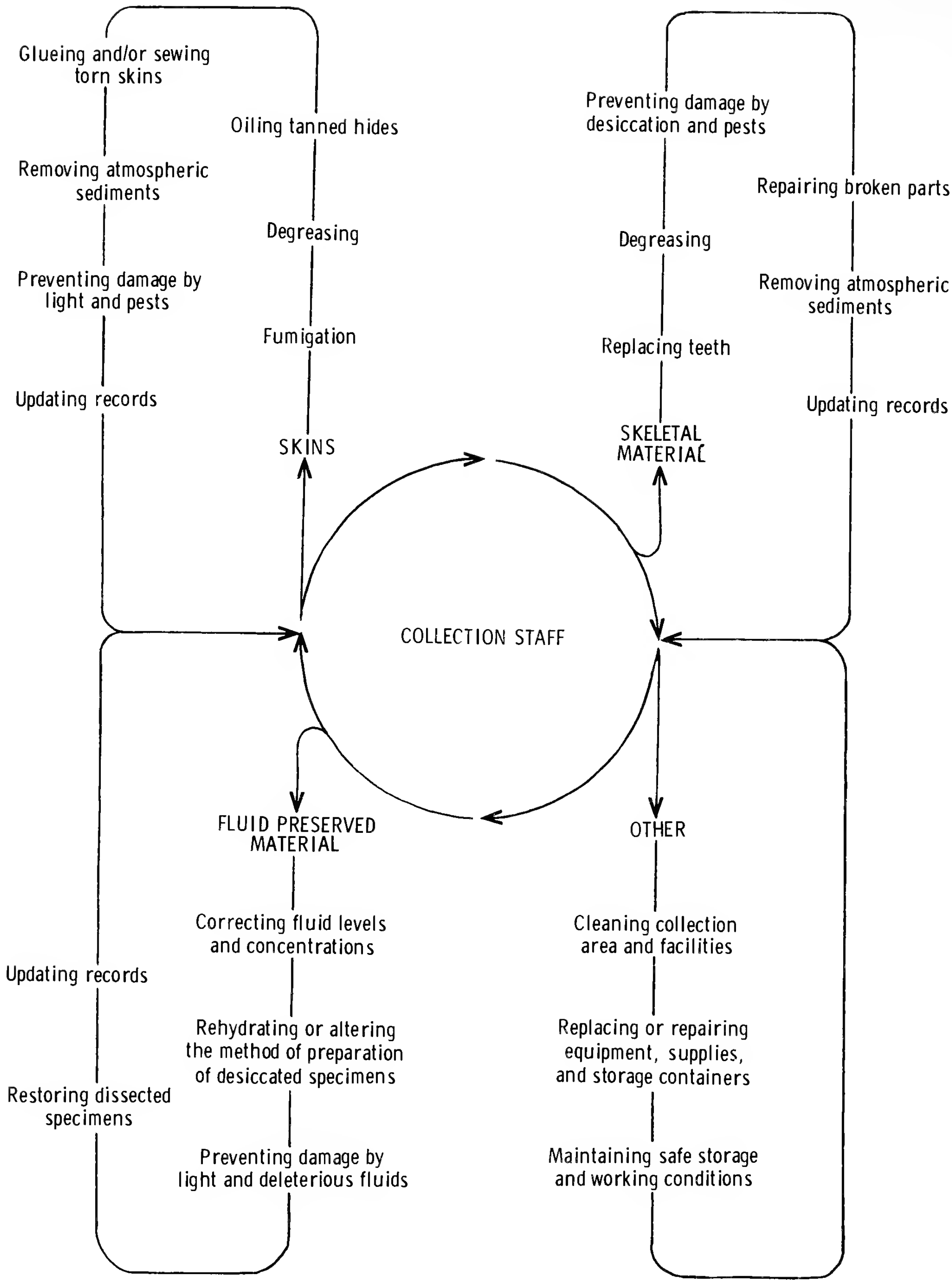



Fig. 35. Flow chart of common maintenance procedures employed in collections of Recent mammals.

At Texas Tech University the same idea has been used satisfactorily for other specimens that are subject to tail damage (for example, *Sciurus, Vulpes, Bassariscus, Procyon,* and *Mephitis*). For many specimens (particularly large specimens) protection from dermestids, moths, and other pests can be incorporated during initial preparation by using Edolan U, borax (Funk and Sherfey, 1975), arsenic (Hall, 1962), formalin (TTU), or Durotex (distributed by Ventron Alfa Products, 8 Congress Street, Beverly, Massachusetts). These substances act as effective repellents. The preventive measures discussed serve as only an example of what can be done to limit later maintenance. Similar procedures can be used in almost any situation. The scope of such procedures is as broad as the ingenuity behind maintenance operations.

## INSURANCE

Every institutional maintenance program should include a suitable insurance policy to take care of most major losses and damages that cannot be prevented through regular maintenance procedures. The collection and associated facilities and personnel are subject to a multitude of hazards such as fire, explosion, severe weather, flood, riot, malicious mischief, vandalism, theft, accidents to conveyances, and liability (Lawton, 1966). Because of these hazards and many others, consideration should be given to purchasing insurance protection for items such as the permanent collection, material sent out on loan, material received on loan, buildings, equipment, liability of the institution and its staff members, and any other valuable assets or areas of responsibility of the institution.

For most property insurance (for example, "Public Institution Form" policy, "Valuable Papers" policy, "Fine Arts" policy) the institution should request "all risk" coverage (Du Bose, 1969). Such coverage provides protection for all risks of loss or damage from any external source, with the standard insurance exclusions. Briefly, these exclusions include losses and/or damages (Keck *et al.*, 1966; Lawton, 1966; Sanford, personal communication; Vance, 1969) resulting from:

1) Wear and tear
2) Atmospheric and/or temperature fluctuations
3) Deterioration
4) Animals
5) Inherent vice
6) Unexplained disappearances disclosed upon inventory
7) Specific cases of mechanical damage or breakdown, breakage of fragile items, and superficial damage
8) Pilferage or theft of insured items which were left unattended in a vehicle lacking any precautionary or security measures
9) Artificially induced electrical injury or disturbance
10) Acts of war

If protection from any of these exclusions is considered necessary by the institution, it may be possible to write a special provision for this purpose. This procedure will usually require higher premiums and additional restrictions and controls on the institution.

Insurance for collections may be divided into two basic types, depending on the use of the collection. If the institution sends or receives major portions of its holdings on a loan basis, which travel from location to location (usually for public viewing), insurance companies categorize such collections as "loan collections." However, if the institution maintains and stores its holdings on a constant basis, with the only exception being occasional restricted loans, such collections are considered to be "permanent collections" (Lawton, 1966). Most, if not all, Recent mammal collections would fall into the category of permanent collections as far as insurance is concerned.

Insurance for permanent collections is usually a flat rate and subject to renegotiation when the insurance contract is renewed. Because the actual holdings of the collection may be difficult to ascertain, particularly when the collection is increasing in size on a regular basis, the insurance policy should contain a "valuation clause." This option will allow full coverage of the collection without any requirement of knowing the exact quantity and type of holdings. However, this option does require that an inventory system be maintained (Keck *et al.*, 1966; Lawton, 1966). The standard accession and collection catalogs should serve this purpose. In the event of a loss, the institution must provide the insurance company with a description and value of the lost material.

The practicality of insuring permanent collections has been questioned (Pfeffer and Uhr, 1974). The high cost of premiums, particularly for large collections, and limited budgets tend to discourage insurance practices (Pfeffer and Uhr, 1974). Such practices are further discouraged by the contentions that

some items are irreplaceable (for example, rare, protected, and endangered species), and most other items cannot be properly evaluated because there is usually no commercial value involved. If the institution cannot, or will not, insure the entire permanent collection, consideration should be given to insuring valuable parts of the collection, particularly if such parts include commercially valuable material like furs or ivory.

Although Recent mammal collections are categorized as "permanent collections," loan procedures are standard practices. Because loans of collection materials expose them to the greatest risk of loss or damage of specimens, and the institution is unconditionally responsible for material received on loan, it is imperative to have loan insurance (Lawton, 1966). Loans may be partially insured through the postal services, but this coverage is restricted to time in transit and specific geographical regions. Because loan shipments are not insured at their destination or in many foreign situations, the importance of loan insurance is further stressed. A loan insurance policy should include "wall to wall" or "floating" coverage. "Wall to wall" coverage will provide insurance protection on loans from the time of departure to the time of return. The "floating" coverage provides protection for loans in transit under any circumstance (for example, boat, aircraft, and various vehicular conveyances), within its territorial limits (Lawton, 1966).

Insurance for buildings presents some unique problems. One problem is fluctuation of value because of depreciation or inflation. In addition, the cost of insuring such structures can be expensive. In spite of these factors, it may be possible to provide adequate protection and coverage at a reduced cost through the use of coinsurance (Lloyd-Thomas Company, 1958). The insurance company may have a provision for a coinsurance policy to encourage the purchase of more insurance by providing a discount for more complete coverage. This form of insurance allows the institution to insure a percentage (for example, 80 or 90%) of the actual cash value of the building, with the understanding that it is also responsible for the difference in cash value, in the case of loss or damage. Therefore, it is necessary for the institution to monitor the value fluctuations of the buildings so that excessive premiums are not paid if the buildings depreciate. On the other hand, the owner must not allow the coverage to decrease by inflationary increases in the actual value of the buildings, because such changes result in penalties for the institution in the case of loss or damage.

Because of the expense and complications of insuring buildings, most institutions operated by state or federal agencies do not have insurance for the buildings they maintain. For all practical purposes, the cost of replacing any single structure would be minimal as compared to the total cost of insurance required to protect *all* buildings maintained by the agency. Therefore, over an extended period of time the investment of the agency, to correct losses or damages, is considerably reduced.

In addition to insurance for collections, loans, and buildings, the institution may need insurance protection for various other items. Such protection may be applied to equipment, documentary records, and staff (hospitalization, life, and pension coverage). In addition, the institution may need insurance against specific hazards, such as steam boilers, fire sprinkler systems, and inherent vice (Du Bose, 1969). The types of insurance coverage required depend on the special needs of the institution. For this reason, the insurance company should be consulted for the most appropriate protection for a given situation.

One final type of insurance that should not be overlooked (except perhaps by state and federal operations that often are protected by statutory immunity) is liability coverage for the institution and its staff members (Du Bose, 1969; Lawton, 1966; McGrath, 1974; Pfeffer and Uhr, 1974). The most common liability insurance coverage is for vehicles (used by the institution) and general liability (Du Bose, 1969). General liability coverage protects the institution and staff in the case of legal suit resulting from claims of negligence (for example, safety of people and property) (Du Bose, 1969; Lawton, 1966; Pfeffer and Uhr, 1974). In conjunction with the liability insurance it may be advisable to include "personal injury" coverage for cases of false arrest, slander, or a similar situation (Du Bose, 1969). Professional liability insurance may also be acquired, but the benefits of such a policy are questionable when considering the professions associated with Recent mammal collections. Because professional staff and associates of an institution may unconciously or unwillingly become liable for actions performed in the line of duty (for example, violation of state or federal laws by personally maintaining and being responsible for permits that cover the action of others *or* receiving improperly marked shipments of biological specimens) the feasibility of insurance

protection should be discussed with the insurance company. Some institutions do maintain professional liability insurance for employees for errors of omission or commission with regard to actions performed in the line of duty at the institution. The primary provisions of all liability insurance policies are payment of legal defense, settlement, and damages for claims (Lawton, 1966).

In most cases, the total cost of insurance for institutions (such as museums) is probably very expensive when considering the actual return to the institution. Although statistics on the subject are essentially non-existent, Pfeffer and Uhr (1974) found insurance loss ratios for art museums to be 0.83, 2.98, and 1.62% of premiums paid for building and improvements, permanent loss, and loan collections, respectively. These ratios reveal that for all premiums paid, only four % was used for loss adjustments. In most instances, loss adjustments amount to the cost of replacement (minus depreciation) or repair of the items reported in the claim. Normally, insurance companies expect to repay about 65% of the total investment (Pfeffer and Uhr, 1974). Under the present conditions and rates, an institution might expect to make monthly payments of $0.021 per $100 of permanent collection holdings, and $0.042 per $100 of loan collection holdings. In other words, if a Recent mammal collection values its holdings at $100,000, the institution would have insurance premiums amounting to approximately $300 per year. This value is based on coverage for only the permanent collection, material sent out on loan, material received on loan, and loans in transit. It does not include protection for buildings, liability, or any other coverage the institution may desire.

Because the needs and requirements of various sizes and types of institutions (for example, private, local, state, federal, and university) vary considerably, such institutions are considered to be an "uncontrolled class" as far as insurance is concerned. Therefore, insurance policies, premiums, and coverage also tend to be variable and entirely subject to the knowledge, interpretation, and judgment of the underwriter (Lawton, 1966). This haphazard insurance procedure has encouraged the support of standardized insurance forms (Vance, 1969) and pooling of insurance policies (Pfeffer and Uhr, 1974). Such practices are appealing because they have been successfully incorporated for other establishments; they allow the institutions more bargaining power; favorable insurance items from various institutions could be consolidated into one policy; basic insurance requirements (for example, liability, all-risk, and loan coverage) would become standardized; and the net result of such operations should be better insurance at a lower cost. Allen and Block (1974) point out that pooling also attracts less desirable risks, thus causing rates to increase; causes monopolistic situations that absorb competing markets; tends to result in less flexible insurance contracts; and creates situations that allow the insurance company to increase rates at their own discretion. Therefore, it is possible for an institution to get a policy that is equivalent to or better than a policy offered by an insurance pool, particularly if the insurance company and institution maintain a good relationship (Allen and Block, 1974). The institution can also effectively reduce its insurance rates by establishing and enforcing professional standards of institutional operations; improving security; eliminating fire hazards; installing alarm systems; conducting regular revaluation and inventory of holdings; maintaining crowd control; maintaining a professional and qualified staff (including a conservator); maintaining standard loan procedures (packing, sending, receiving); differentiating items that should or should not be insured; accepting loss limits; accepting deductibles; being selective on items to be sent out on loan; comparing policies from various insurance companies; reducing coverage or using specified loss-limit coverage; providing the insurance underwriter with as many facts and details as possible (Allen and Block, 1974; Lawton, 1966; Pfeffer and Uhr, 1974; Vance, 1969); and consolidating several policies into a single "package policy" (Du Bose, 1969).

In conclusion, almost anything can be insured for any amount if someone is willing to pay the price. Any institution can obtain an insurance policy that will suit its specific requirements. In the event that an institution plans to insure any of its holdings, it is recommended that several insurance companies be consulted and their proposals compared before any particular policy is accepted. Such companies should have the capacity to properly insure institutions maintaining collections; should offer good "inland marine" policies (a feature often characteristic of companies that insure commercial businesses); and should have a history of qualified, knowledgeable, and reputable service. Once a company is selected, an insurance policy that allows internal consistency, comprehensive coverage, adequate valuation of losses, simple operation, flexibility, and that is clear and understandable (Vance, 1969), should be writ-

ten. After a policy has been drafted, it may be advisable to ask an experienced attorney to evaluate the policy before final agreement between the institution and the insurance company.

## SKIN AND SKELETAL MATERIAL

### FUMIGATION

Insect pests are perhaps the most serious threat to mammal collections. In a very short time, dermestid beetles, clothes moths, and other pests may destroy a substantial portion of a mammal collection. The curator and his staff must be constantly alert for signs of infestation. A routine inspection schedule should be established. Periodic fumigation of all storage areas is absolutely essential. All incoming material must be fumigated immediately because this isoften the greatest source of harmful pests (Hildebrand, 1968).

If dermestids are used to clean skeletal material, the latter must be fumigated or heated to 100°C immediately following its removal from the colony. Fumigation is also recommended for specimens received on or returned from loan, as well as for specimens stored for a long time in other external cases (for example, cases used for research projects, classroom teaching, and the like). After unpacking, the newly acquired specimens and the packing material should be placed in an airtight specimen-storage case or other suitable container set aside for fumigation (Knudsen, 1966). A quantity of fumigant, depending upon type, size of chamber, temperature, and degree of infestation is then introduced into the fumigation chamber. To insure extermination of pests, fumigation should range from 48 hours to two weeks, depending upon the fumigant used.

Periodic fumigations of the dry-specimen collection (for example, skin and skeletal material) are rather standardized, with the exception of the type of fumigant used. Most collections of Recent mammals should be treated at least twice a year and more often, if necessary. The agent, whether of a gaseous, liquid, or solid type, is placed in each specimen case for a period of time sufficient to allow extermination. Liquid and gaseous fumigants should be used only by institutions having adequate air-exchange systems. During this procedure, conducted during periods of little or no collection utilization, cases should remain tightly closed to allow maximum fumigant effectiveness as well as to minimize health hazards to staff. Many mammal collections (for example, ROM, UCONN, and VMKSC) maintain only a crystalline agent in all cases at all times. Other collections (for example, USNM, WFBM, PUWL, MHP, KU, CM, TTU, and UWZM) use a liquid fumigant several times a year. Still other institutions (for example, MVZ, UMMZ, MMNH, OSMNH, and TCWC) combine the two approaches, using a liquid fumigant for incoming material and for heavy infestations, and periodically for the entire collection, while maintaining a crystalline fumigant in each case at all times.

All fumigating agents are potentially hazardous and should be handled with care and only by personnel familiar with the proper precautionary measures. All cases containing fumigant should be appropriately marked.

The common collection fumigants, their properties, effectiveness, directions, and precautions for their use are discussed below.

CARBON DISULPHIDE (Carbon bisulphide, $CS_2$): This substance has a molecular weight of 76.13, a boiling point of 46.3°C (115°F), and ignites spontaneously at about 100°C (212°F) (Monro, 1961). Fumigant is evolved by evaporation of the liquid. Odor is sweetish when pure. Added impurities, for example, sulphur dioxide ($SO_2$), give the characteristic unpleasant odors. Carbon disulphide tends to burn or explode at relatively low temperatures. Carbon disulphide's high degree of flammability and harmful effects should preclude its use in collections. It is extremely toxic, producing a narcotic effect in high concentrations and may even cause death. Absorption may take place through the skin at high concentrations, and prolonged contact with the liquid or vapors may result in severe burns (Monro, 1961). Because the vapors are heavier than air, shallow containers containing approximately 15 cubic centimeters (cc) of fumigant for standard-size museum cases should be placed in a tray near the top of each case. According to Storer (1931) 592 cc (567 grams) per 254 cubic meters (1000 cubic feet) of space is a safe minimum for collection usage. Various liquid fumigants may also be dispensed onto absorbent material such as cotton, which has been attached to the inside of storage case doors. Some cases are fitted with a special receptacle for fumigants on their doors. Carbon disulphide was perhaps the most frequently used fumigant in mammal collections (for example, MVZ, WFBM, MHP, KU, OSMNH, and TCWC). This liquid fumigant is seldom used alone but rather in mixture with fire retardant additives

such as carbon tetrachloride. In mixture with carbon tetrachloride, carbon disulphide is a successful fumigant utilized by some institutions (for example, TTU). These formulas usually consist of 80% carbon tetrachloride and 20% carbon disulphide, together with small amounts of sulphur dioxide and other fire-inhibiting additives. These mixtures are relatively stable and do not constitute as great a fire hazard (Monro, 1961). It should be noted that sulphur dioxide, as an atmospheric pollutant, is deleterious to collections (see STORAGE).

ETHYLENE DICHLORIDE ($CH_2Cl$-$CH_2Cl$): This has a molecular weight of 98.97 and a boiling point of 83.5°C (182°F). Fumigant is evolved by evaporation of the liquid. Odor is reminiscent of chloroform (Monro, 1961). This liquid is almost always mixed with carbon tetrachloride for use as a fumigant because, like $CS_2$, it is highly flammable in pure form. Mixtures used by collections (for example, USNM, UMMZ, OSMNH, CM, and UWZM) usually consist of 75% ethylene dichloride and 25% carbon tetrachloride by volume. One mixture, marketed under the trade name Dowfume 75, has a 70% and 30% composition of ethylene dichloride and carbon tetrachloride, respectively. Dizziness may result from exposure to fumes and permanent damage may be inflicted by sustained exposure to very high concentrations. Schantz (1949) reported on the successful use of an ethylene dichloride-carbon tetrachloride mixture. Application procedures are the same as those for carbon disulphide-carbon tetrachloride mixtures. Its action is reportedly more delayed than pure $CS_2$ but it is less flammable and just as satisfactory (Schantz, 1949). At the National Museum of Natural History Dowfume-75 is pressurized inside Navy shell canisters and then sprayed into vessels within each storage case. Both gloves and masks (see precautions below) are worn during the operation, which is performed twice yearly (Setzer, personal communication). It is recommended that fumigation with Dowfume-75 be at least 96 hours in duration, using a minimum of 50 cc for each 0.34 cubic meters (12 cubic feet). After fumigation is completed, the cases should be opened. Utilization of the collection area can be resumed after the concentration of fumigant in the air is below ten parts per million. This ratio can be measured by a Gas-Tech Model 1230 Halide Detector (Anon., 1976). Dowfume-75 is soluble in fats and oils, and therefore has the potential to damage prepared skins if contact occurs. It may also have harmful effects on plastic vials.

The Federal Environmental Pesticide Control Act of 1972, effective as of October 1977, states that,

> ". . .it shall be unlawful for any person in any State to distribute, sell, offer for sale, hold for sale, ship, deliver for shipment, or receive and (having so received) deliver or offer to deliver, to any person . . . to use any registered pesticide in a manner inconsistent with its labeling." (Public Law 92-516 Sec. 12)

This law prohibits the use of any fumigant not properly labeled in the affirmative as being safe for collection use. Dowfume-75 is the only current fumigant with labeling allowing legal use for institutional collections.

PARADICHLOROBENZENE (PDB, $C_6H_4Cl_2$): This has a molecular weight of 147.01 and a melting point of 53°C (127.4°F). Paradichlorobenzene is a crystalline fumigant that sublimes to give off vapors. It is used as a "constant fumigant" by many collections of Recent mammals (for example, ROM, UCONN, UMMZ, VMKSC, MVZ, OSMNH, and TCWC). The fumes are not flammable as ordinarily used. According to Cotton (1956) "the vapors are not considered to be harmful to man." It is advisable, however, not to remain exposed to a high concentration of vapor for long periods of time. Jackson (1926) described the effects of PDB upon *Dermestes* and tenioid (clothes) moths. Sufficient quantities in continuous use will keep pests from entering storage cases and will prevent their feeding when present. At higher concentrations, insects are killed, as reported by Dudley and Wilkinson (1968) for both adult and larval tenioid moths. Paradichlorobenzene is an effective repellent of insects when used on a continuous basis in proper amounts. The crystals may be placed in small cloth bags or paper cups if case doors are not equipped with receptacles. If too much PDB is placed in a case, supersaturation of the air occurs with resultant recrystalization on the case, holding trays, or even on the specimens themselves. In addition, plastic vials may become opaque or even "dissolve." PDB will react with Styrofoam and hence should not be used in connection with that synthetic, e.g., in shipping crates. Polyethylene foam is not affected in this way. Paradichlorobenzene may also retard mold formation in humid climates (Van Gelder, 1965). It apparently does not alter pelage color unless direct contact is made. Because its volatilization rate is much slower than that of liquid fumigants, it is more useful

as a repellent than as a pesticide except when used in the highest concentrations. The crystals, however, are easier and safer to dispense than the liquid agents.

NAPHTHALENE ($C_{10}H_8$): This has a molecular weight of 128.06 and a melting point of 80.1°C (176°F) (Monro, 1961). Although naphtalene is slow to act, its vapor is quite toxic to insects (Monro, 1961). It is more economical to use than PDB because smaller dosages are required. Long (1970) recommends using 0.45 kilograms (1 pound) for each 2.83 cubic meters (100 cubic feet) of space. Its use in loan shipments is recommended. Naphthalene is also applied in the form of crystals or flakes. It is not as volatile as PDB, but is effective in tightly sealed containers, a prerequisite for the successful use of any solid fumigant.

DDVP (2,2 dichlorovinyl dimethyl phosphate, Shell No-Pest Strip, Vapona): This moderately volatile insecticide evolves vapors that are highly toxic. It is currently in use (for example, FSM and UPS) as a collection fumigant much in the same manner as PDB. The solid stick contains 20% DDVP and related compounds. It is divided into appropriate sized pieces for use in specimen storage cases. Vapors are released at a uniform rate over a period of several months (Monro, 1961). Satisfactory results of extended use of DDVP has been reported (for example, UPS). However, Setzer related the unsuccessful use of a full strip of the fumigant within a small storage case containing bird specimens. Dermestid beetles were still alive two weeks following treatment. Setzer doubts its effectiveness against coleopterans. DDVP does not irritate mucous membranes and so is less objectionable to work with than other agents, but prolonged exposure to the vapors and contact with the skin should be avoided.

Other fumigants of various types that have been or are still in use by various institutions include Carboxide (for example, CM) for fumigating fur vaults, DDT (Anderson, 1965), and ethyl acetate-carbon tetrachloride (Jackson, 1926).

Fumigants are known to act on an insect, whether it is in the larval, pupal, or adult stage, by entering the respiratory system via the spiracles. Fumigants apparently penetrate the chorion of the egg by diffusion, or perhaps through specialized "respiratory channels." The effectiveness of a given fumigant is in part influenced by the respiratory rate of the insect, which in turn is directly affected by the ambient temperature. The importance of fumigant diffusion through the external surfaces of insects is not well understood (Monro, 1961).

Temperature is the single most important factor determining fumigant effectiveness. Less fumigant is required at higher temperatures. Temperatures of 21° to 24°C (70° to 75°F) seem to be optimal. At lower temperatures more gas is absorbed by the material being fumigated, leaving less available to kill the pests.

Precautions that should be taken while fumigating:

1) Always follow the directions for use and precautions listed on the fumigant container label
2) No person should work alone, no matter how small the job
3) Respirators (gas masks) fitted with the appropriate filter-type canister, and rubber gloves should be worn by fumigating personnel
4) Smoking and other sources of ignition must be strictly forbidden during fumigation
5) A first-aid kit with antidotes and instructions for treatment in case of poisoning should be available
6) Be sure that the fumigant being used does not have adverse effects on specimens, equipment, or any other facilities that will be in contact with the fumigant
7) Be sure that all procedures used in fumigating comply with the Occupational Safety and Health Act of 1970, to avoid liability suits (Anon., 1976).

## TANNED HIDES

A substantial portion of a collection's holdings may be in the form of tanned hides. Periodic inspection is necessary because they often require oiling to ensure that they will remain supple and pliable, and so resist tearing. The effects of dessication may be thus avoided. A solution of sulphonated neatsfoot oil and warm water in equal proportions should be applied to the "flesh side" of the hide (Moyer, 1953).

## DEGREASING

Fatty tissues should be thoroughly removed from skins at the time of preparation. If this is not done, grease may subsequently ooze from the specimen by capillary action. These natural oils and constituent fatty acids, when in overabundance, will oxidize and burn the skin fibers of a prepared specimen. The weakened skin fibers then tear easily. In addition, skeletal material may exude grease for long periods of time if not properly handled during

processing. This material will discolor, give off disagreeabe odors, readily collect dust, attract pests, and generally become undesirable to handle. Maintenance of such specimens may involve various degreasing methods more adequately described elsewhere (Anderson, 1965; Fleming, 1926; Hudson, 1935; Sherman, 1925; Sommer and Anderson, 1974). These processes normally involve the immersion of the specimen in a grease solvent for a given length of time and subsequent removal of the excess solvent from the specimen with absorbent material. This is followed by air drying. Carbon tetrachloride is the most commonly used grease solvent because of its excellent and quick results, and nonflammability. However, the toxicity of this solvent requires good ventilation and safety precautions. White gasoline is also a good grease solvent, but its flammability makes it less desirable for use (Knudsen, 1972). A new product, K-2 spray powder, provides a quick, nonharmful, and effective method for degreasing small and delicate specimens. However, this product is expensive and does not remove deep or fixed grease (UPS). Dirty skeletal specimens may be washed in warm water and detergent, rinsed with fresh water, and dried. They may be bleached with a 4% solution of hydrogen peroxide (Sommer and Anderson, 1974).

When treating skins with solvents, the possibility of changes in pelage color must always be taken into consideration. The extent of color changes, if any, generally depends upon the length of time the specimen remains in the fluid (Fleming, 1926). If a skin has been treated, it is suggested that such treatments be noted on the skin tag (UWZM).

## SPECIMEN REFURBISHING AND REPAIR

Occasionally, mammal specimens require refurbishing or repair. A specimen's research value may be greatly enhanced by such attention. On the other hand, repair attempts by unskilled workers may result in still greater damage to a specimen.

Commonly incurred damages to mammal specimens include fading of pelage color ("foxing"), loosening and loss of teeth, tearing of prepared skins, dessication, accumulation of foreign materials (for example, dust, soot, and grease), and damage by pests (for example, insects and rodents). Pelage fading of study skins and fluid-preserved materials, and destruction caused by insects are irreversible. In cases of insect damage, a falling-hair condition may be inhibited to some extent by the use of commercial hairspray.

Torn study skins and tanned hides are often repairable. Separated appendages can often be reattached with the use of certain impervious liquid adhesives (for example, Duco Cement), when done carefully. A properly applied brace will afford support during the drying process. Merely securing the torn appendage to the specimen with string may be satisfactory when gluing is not possible. Small parts (for example, bat nose leafs) might be placed in an envelope or vial. Tanned hides that have been torn can usually be sewn, or a leather or cloth (for example, canvas, burlap, etc.) patch may be applied to the flesh side of the skin with a liquid adhesive to prevent further tearing of the hide.

Accumulated dust can often be removed from specimens by compressed air if the dust is not held by grease on the skin. Warm hardwood sawdust, cornmeal, or bran may be employed to remove dirt and grease from skins. After working the material into the hair, it may be removed by the use of compressed air or a vacuum cleaner blower attachment (Grantz, 1969). If a skin is still greasy, it is possible to clean it by soaking the entire specimen in naphtha or white gasoline for about 30 minutes. Following this procedure, the specimen should be brushed with sawdust or cornmeal, and allowed to dry.

Loosening of teeth and fracturing of skeletal material, constant problems in collections of Recent mammals, often result from moisture loss from the bones. This can be partially prevented by coating bones with a sealer. Care should be taken to avoid using sealers in quantities that would affect the dimensions of the bone. If damage of skeletal material has occurred, repairs can be made through the use of liquid adhesives. The pure adhesive (for example, Duco Cement) can often be thinned with appropriate liquids (for example, acetone) to the desired consistency and applied with a brush. Care should be taken to keep adhesives off the crowns of the teeth. Ambroid Cement, as recommended by Anderson (1965), may be dabbed on a wisp of cotton which is then wrapped around the roots of the tooth before its replacement into the alveolus. This adhesive is reputed to have many uses, depending upon the amount of solvent mixed with it, and has the distinction of not contracting with the elapse of time as do some other adhesives. Applied in a thin coat, it successfully inhibits fracturing and holds together already-cracked osteological material. Although discoloration may result when too thick, it can be removed easily with acetone (Anderson,

1965). Loose teeth may also be reset, at least temporarily, with the use of plasticine, as described by Anderson (1965). The teeth are held effectively and may be removed subsequently for examination.

## FLUID-PRESERVED MATERIAL

A substantial portion of the institution's holdings are normally stored in preservatives such as alcohol, embalming fluid, buffered formalin, glycerin, and others. Accordingly, a proportionate amount of time must be spent in maintaining these specimens in good condition.

### FLUIDS

Fluid levels must be adequate to ensure that the specimens are covered by the preservative. A regular inspection schedule should be established. During such inspections, perhaps three times annually, each vessel should be examined for loss of preservative. When the addition of fluid is required, concentrations of the remaining fluid should first be ascertained using an alcoholometer or alcohol hydrometer. A stronger additive solution (different types of preservative should not be mixed) may be required to re-establish the original concentration. A table of dilution factors for alcohol is given by Wagstaffe and Fidler (1955). Jars and other storage vessels should be filled as close to the brim as possible to make any subsequent loss of fluid more readily discernible.

Maintenance of the fluid-preserved holdings often involves replacement of the storage vessel or part thereof. Metal lids rust, some plastic lids crack or loosen, glass jars and earthenware crocks occasionally break, and cap liners and rubber gaskets require replacement (Palmer, 1974). Ground-glass jars require periodic replenishment of the grease seal between lid and jar. Crocks, whose exterior glaze eventually deteriorates and allows seeping of preservative (Zweifel, 1966), also require special maintenance. Levi (1966) recommends Dow silicone grease rather than petroleum jelly as a seal.

Numerous attempts have been made to overcome the fluid evaporation problem. Isopropyl alcohol seems to evaporate more slowly than ethyl alcohol (Zweifel, 1966). Use of Marathon parafilm M sheets in conjunction with metal Ball jar lids and others has been somewhat successful (Zweifel, 1966) but replacement of the film liner is necessary each time a jar is opened. Levi (1966) cites the use of 3M tape No. 472 to create a better seal between lid and jar. Sealed jars may also be dipped in Uniroyal Industrial Adhesive No. 6273 to create a better seal (Levi, 1966). Such treatment must be repeated, however, each time a vessel is opened.

Storage of specimens in a smaller receptacle within a larger one is hardly feasible with mammal specimens. Dessication problems can be virtually eliminated by the use of good quality storage vessels and periodic and thorough inspection.

### REFURBISHING AND REPAIR OF ALCOHOLIC MATERIAL

Mummified specimens may sometimes be rehydrated by passing through a graded series of alcohols to water. A 1% solution of trisodium phosphate in water has been used to recondition invertebrates (Levi, 1966). Reconstitution of dried-fish specimens in a weak solution of potassium hydroxide was suggested by Smith (1965). Propylene glycol has been found useful in rehydrating mummified specimens. For rehydrating skin and other tissues, a diluted laboratory aerosol solution (Dowler and Genoways, 1976) is recommended (USNM).

Skulls are often removed from fluid-preserved specimens in the course of identification. Cotton should be inserted in the head skin of the specimen to simulate the original size and shape of the head. A few carefully placed stitches to close the lips will prevent subsequent tearing of the head and facial features.

## MISCELLANEOUS MAINTENANCE

In addition, routine maintenance includes the repair and replacement of a great many objects. Vials and vial caps, boxes for skeletal material, pasteboard trays, glass jars, lids, and case drawers are among the numerous items that require such periodic attention.

## UPDATING RECORDS

It has been stated that the data associated with a specimen are at least as valuable as the specimen itself (American Society of Mammalogists, 1974; Van Gelder, 1965). Likewise, availability determines a specimen's real value. A specimen that is unavailable for any reason is for all practical purposes nonexistent.

The curator and his staff must be aware of the taxonomic developments as documented in the scientific literature. A genuine effort must be made to indicate such changes in taxonomy on the specimens of the group affected, whether such revisions were gained through examination of the literature, direct

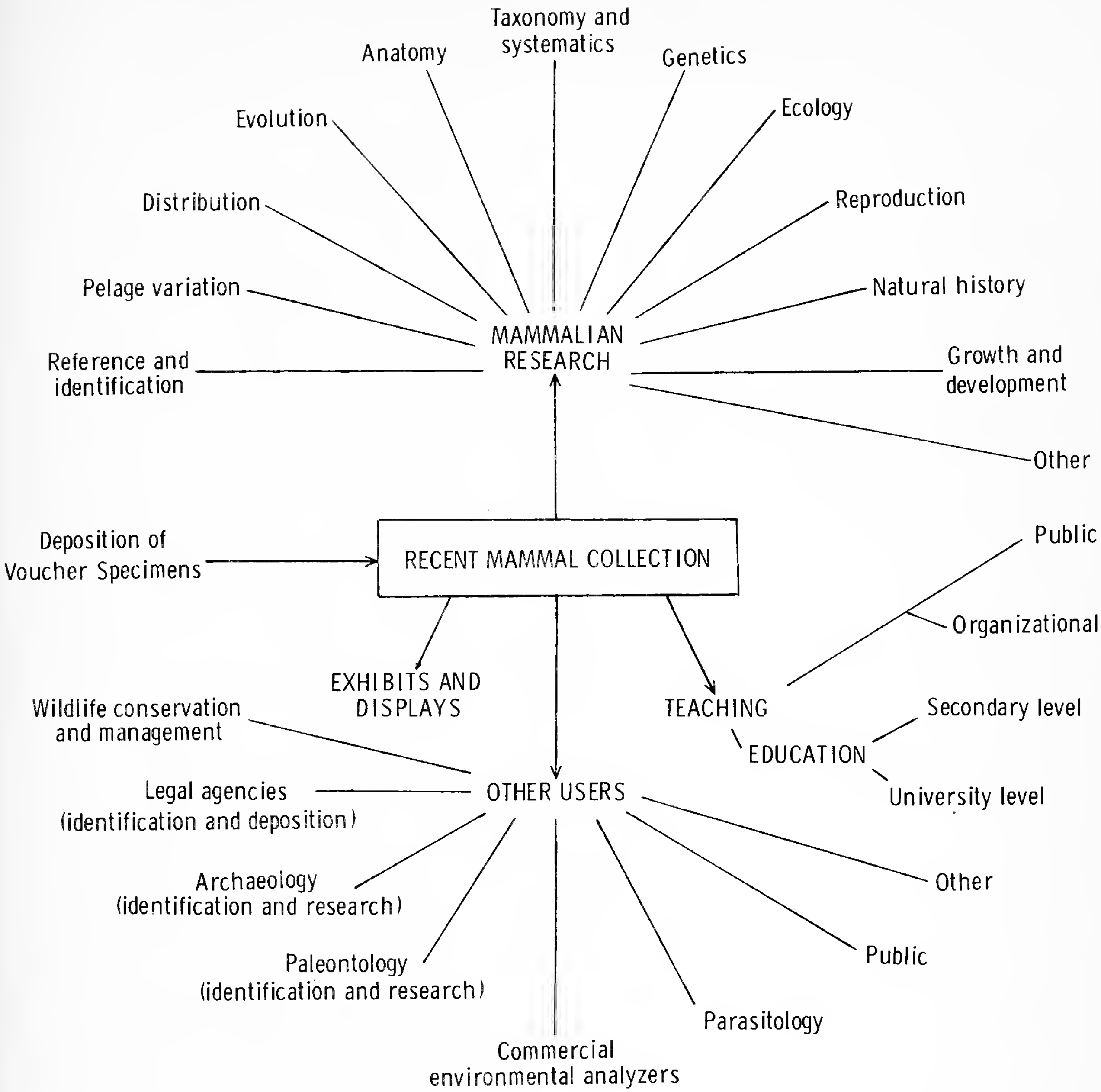
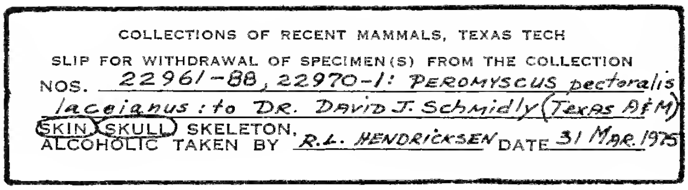



Fig. 36. Chart of general types of utilization of Recent mammal collections.

examination of the material by a specialist in a certain group, or through institutional research efforts. The amount of time spent in such endeavors may be considerable, especially in the larger collections where specimen numbers and overburdened staffs may not allow quick attention. Of necessity, this updating may be of low priority in some collections.

Updating collection records may involve taxonomic changes due to misidentification or revision, changes of availability, or any other necessary addition or change of pertinent information. When updating, annotations should be made on all records, such as skin tags, labels for skeletal material, drawer and case labels, collection catalogs, card files, and computer records. The name of the reviser and the year of the revision may be entered in the catalogs, or on specimen labels, so that subsequent investigators will be able to refer to the original literature. Any change in the availability of a specimen, such as loss, exchange, or sale should be indicated in the catalog as well. A red pencil is often used for indicating permanent changes.



COLLECTIONS OF RECENT MAMMALS, TEXAS TECH
SLIP FOR WITHDRAWAL OF SPECIMEN(S) FROM THE COLLECTION
NOS. 22961-88, 22970-1: Peromyscus pectoralis laceianus: to Dr. David J. Schmidly (Texas A&M)
SKIN SKULL SKELETON, ALCOHOLIC TAKEN BY R.L. Hendricksen DATE 31 Mar. 1975

Fig. 37. Slip for withdrawal of specimens from the collection. This slip is left in the place of specimens removed from the collection. Original color of slip was blue, but any conspicuous color will suffice. Original size of slip was 23 by 89 millimeters.

# UTILIZATION

Genoways *et al.* (1976) have undertaken a search to identify mammalian systematists and other users of collections of Recent mammals. These collections, as well as the biology libraries associated with them, receive usage from a great variety of sources and for a great many endeavors (Irwin *et al.,* 1973; Conference of Directors of Systematic Collections, 1971). Research, reference, education, and exhibition are among the major uses (Fig. 36).

## INTERNAL USAGE

### STAFF AND VISITOR USAGE

The primary function of most collections of Recent mammals is one of research and documentation. The prudent and appropriate use of uncataloged specimens in other endeavors (for example, education) should not, however, be underestimated.

Research specimens should always be handled with due respect, in a careful, conscientious manner. Persons not trained to appreciate specimen value or who are otherwise unfamiliar with proper procedures should refrain from handling research material. Specimens should never be picked up by a single appendage; in fact, they should be handled as infrequently as possible. It is good practice to return specimens to their appropriate storage areas at times when they are not being examined or curated. At the very least, specimens ought to be shielded from dust and light in some manner while outside of the cases.

It may be advisable to have all specimens removed and reinstalled by one individual who is responsible for their whereabouts. It is standard procedure with most collections to leave a withdrawal slip with pertinent information each time a specimen is removed from its place of storage (Fig. 37). The Mammalogy Department of The University of Kansas asks that specimens removed from a case be placed on a "holding cart" when ready for reinstallation, rather than returned directly and perhaps improperly. This is a wise procedure, staff size permitting. Most other institutions (for example, USNM, UMMZ, AMNH, TTU, and UPS) have written regulations regarding use, as well as other aspects of curation, to the benefit of staff and visitors alike. Such guidelines may include directions as to the availability, location, and use of facilities and equipment, as well as for proper specimen removal, handling, and replacement. The manual might also include information regarding institutional hours, policies for key acquisition, property passes, and floor plans. Regulations pertaining to the use of type specimens and loan procedures are likewise usually included in such a manual.

Researchers are urged to examine specimens at the institutions where they are housed. Outside investigators should follow proper procedures in making such visits. They should make contact with the person in charge, relating the purpose, time, and length of the planned visit. Through this courtesy, researchers' needs for equipment and staff assistance, if any, may best be met. The visitor may be requested to reciprocate by helping to curate the taxa in question through his investigations. Most collections maintain guest registers that allow for easy compilation of collection use for annual reports, grant requests, and the like.

### INTRA-INSTITUTIONAL LOANS

Specimens loaned to various divisions or depart-

THE MUSEUM OF TEXAS TECH UNIVERSITY

DEPARTMENT OF MAMMALOGY

INTRACAMPUS LOAN

Requested by Robert L. Packard Date 1 March 1975
Signature Full-time Faculty/Staff Member

To be used by Dr. Robert L. Packard

Purpose Examination for photographic purposes

Specimens will be kept at Personal storage facilities of Packard in Room 421 of Biology Building

Date to be returned 15 March 1975

Authorized by Hugh H. Genoways Date 2 Mar. 1975
Signature of Curator

Packaged by René Laubach Date 2 Mar. 1975

Description of material

Five skins and skulls of male Peromyscus pectoralis laceianus from Texas: Brewster County, as follows:

TTU 22962-18.6 mi. N., 1.2 mi. E. Marathon-mandible separated
" 22963-18.5 mi. N., 1.3 mi. E. Marathon-O.K.
" 22964- " " " - "
" 22970-18.0 mi. N., 3.0 mi. E. Marathon-skin has torn left ear
" 22971-17.3 mi. N., 0.6 mi. E. Marathon-O.K.

Loan picked up by Houston McGaugh Date 3 Mar. 1975

Loan returned by Houston McGaugh Date 15 Mar. 1975

Loan received by René Laubach Date 15 Mar. 1975

Loan checked by René Laubach Date 15 Mar. 1975

Material found in satisfactory (x), unsatisfactory ( ) condition

Fig. 38. Intracampus loan form used at Texas Tech University. Original size was 280 by 217 millimeters.

ments within a single institution are sometimes handled in a rather casual manner. It is necessary, especially in large institutions, to keep some record of these transactions to avoid misunderstandings and possible loss (Fig. 38). Such procedures help control and reemphasize the functions and standards of the collection, and therefore will encourage proper handling and care of specimens on loan to local users.

## EXTERNAL USAGE

The processing of loan requests is among routine procedures at most collections with sizable holdings. Because the institution is prepared to take on the responsibility of loans, such material is always loaned to the institution instead of to the individual. Loan shipments are usually sent to any qualified student or professional upon request. Holotypes should never leave their institutions and so are never loaned (American Society of Mammalogists, 1974). Some institutions (for example, USNM) wisely prefer that type materials be examined in the same room in which they are housed. It is poor policy to send all holdings of a given taxa or generally more than 50 specimens at one time. Both lender and borrower have obligations to the specimens, as discussed below. Specimen loans are normally arranged for a six-month period among most institutions, with renewal usually granted upon request. Borrowers are urged to return specimens promptly following examination. Regulations regarding loan material have, unfortunately, often not been strictly enforced.

Few collections levy fees for the use of research material to bona fide professionals. The borrower may be assessed a fee for labor costs (for example, UMMZ) when requests involve large numbers of specimens. Some museums levy consultation fees on profit-making concerns for the use of collections and libraries. The Royal Ontario Museum charges a variable fee of approximaely $25.00 per skin or mount for such short-term loans.

Specimens received on loan must be given diligent care. Specimens should not be physically altered in any way, such as removing skulls from alcoholic specimens, unless prior consent to such alterations has been received from the lender. It is wise to store fluid-preserved specimens in the same fluid in which they were originally maintained. A note to that effect might be included on the invoice. Damage incurred during shipment must be reported to the lender and the carrier immediately (Long, 1970).

A loan transaction (Fig. 39) usually begins with a written request for specimens. The request should include the reason for the request, the nature and number of specimens desired, the length of time for which the material is required, and any pertinent additional information. A reply letter approving or disapproving the request is then sent to the potential borrower. If the loan is approved it will include information as to when the material will be forwarded. Following assembly of the requested specimens, an invoice (Fig. 40) should be completed in quadruplicate and include the lender's and borrower's names and addresses, authorizing signatures, packer's initials, shipping date, shipping cost, carrier's name, amount of insurance, and a detailed description of the nature and condition of the contents. The original is retained by the lending institution. The borrower receives a second and a third copy, maintaining one for their records and returning the other signed. The borrower indicates any damage to the specimens in transit on the signed copy that is returned. For this reason, loan material should be thoroughly examined with regard to condition upon receipt. A fourth copy should be attached to the outside of the crate in an envelope in accordance with the Lacey Act of 1903 and the Department of Interior regulation concerning "Import, Export, and Interstate Transportation of Wildlife." The latter is a more concise form of the Lacey Act and states,

> ". . . no person shall ship, transport, carry, bring or convey any wildlife in interstate or foreign commerce unless the package or container in which such wildlife is contained has the name and address of the shipper and the consignee and an accurate statement of the contents by species and numbers of each species of wildlife therein contained clearly and conspicuously marked on the outside thereof." (CFR 50.14)

Address labels should be placed inside and on the outside of the package. Such labels should indicate the contents as being, "SCIENTIFIC SPECIMENS; NO ENDANGERED SPECIES; NO COMMERCIAL VALUE" (Genoways and Choate, 1976) (Fig. 41). The post office or latest edition of the *Postal Service Manual* (available from the United States Government Printing Office), should be consulted regarding size and weight limitations or other regulations. Similar procedures should be followed when using private carriers (for example, United Parcel Service).

Packing costs and one-way shipping and insurance

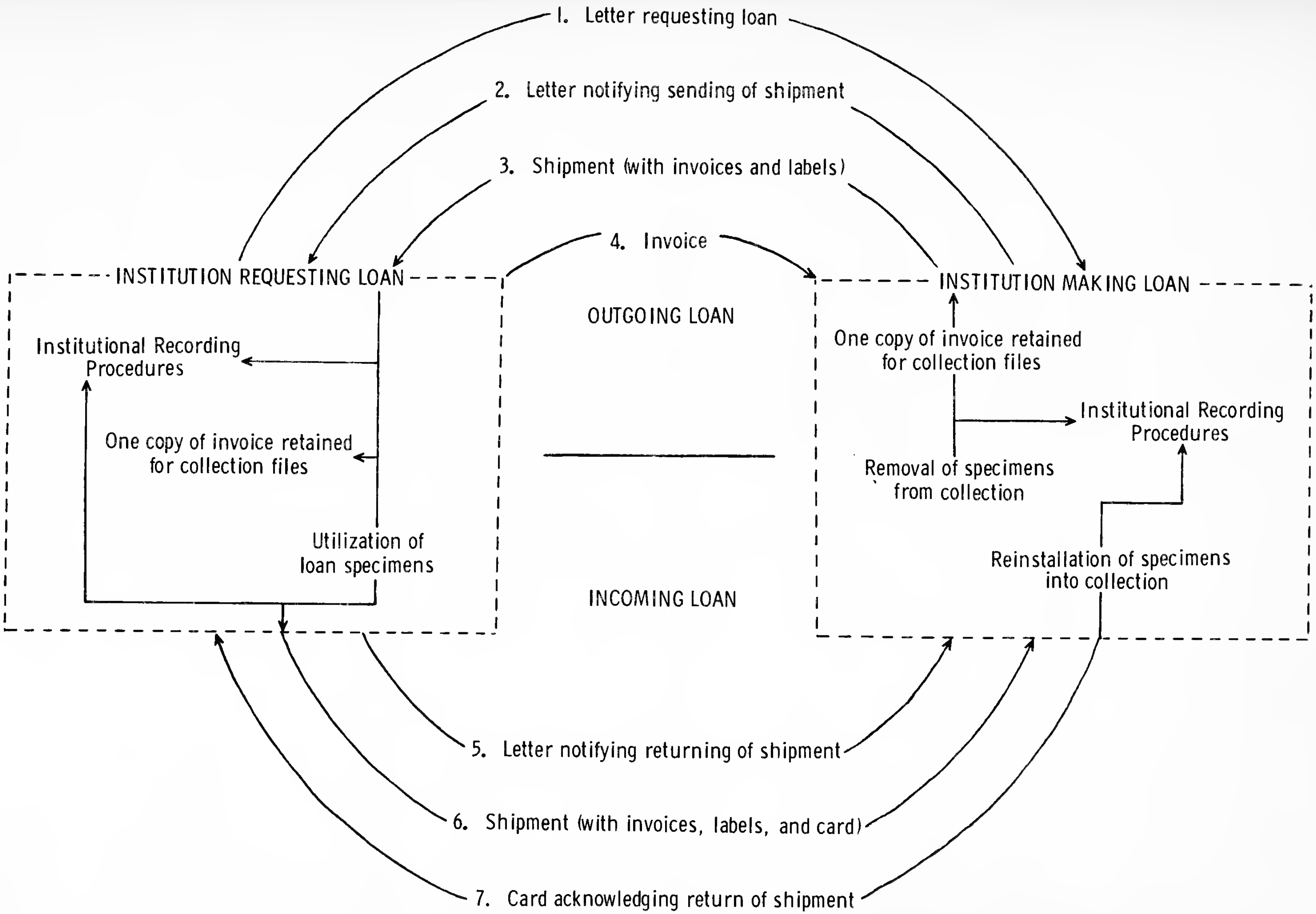



Fig. 39. Flow chart of complete loan procedures used by collections of Recent mammals.

DUPLICATE

The Museum
**COLLECTION of MAMMALS**
TEXAS TECH UNIVERSITY
LUBBOCK, TEXAS 79409

## INVOICE OF SPECIMENS

To: Texas Cooperative Wildlife Collection
Department of Wildlife and
Fisheries Sciences
Texas A & M University
College Station, Texas
(ATTN.; Dr. David J. Schmidly)

Purpose: Loan at your request

Date shipped: 1 April 1975
Shipped via: Prepaid Parcel Post
Checked by: René Laubach
Approved by: Hugh H. Genoways

Number, description, & condition of specimens:

10 skins and skulls of Peromyscus pectoralis laceianus

from Texas: Brewster County, as follows:

Males:

TTU 22962 - 18.6 mi. N., 1.2 mi. E. Marathon-mandible separated
" 22963 - 18.5 mi. N., 1.3 mi. E. Marathon-O.K.
" 22964 - " " " -O.K.
" 22970 - 18.0 mi. N., 3.0 mi. E. Marathon-skin has torn left ear
" 22971 - 17.3 mi. N., 0.6 mi. E. Marathon-O.K.

Females:

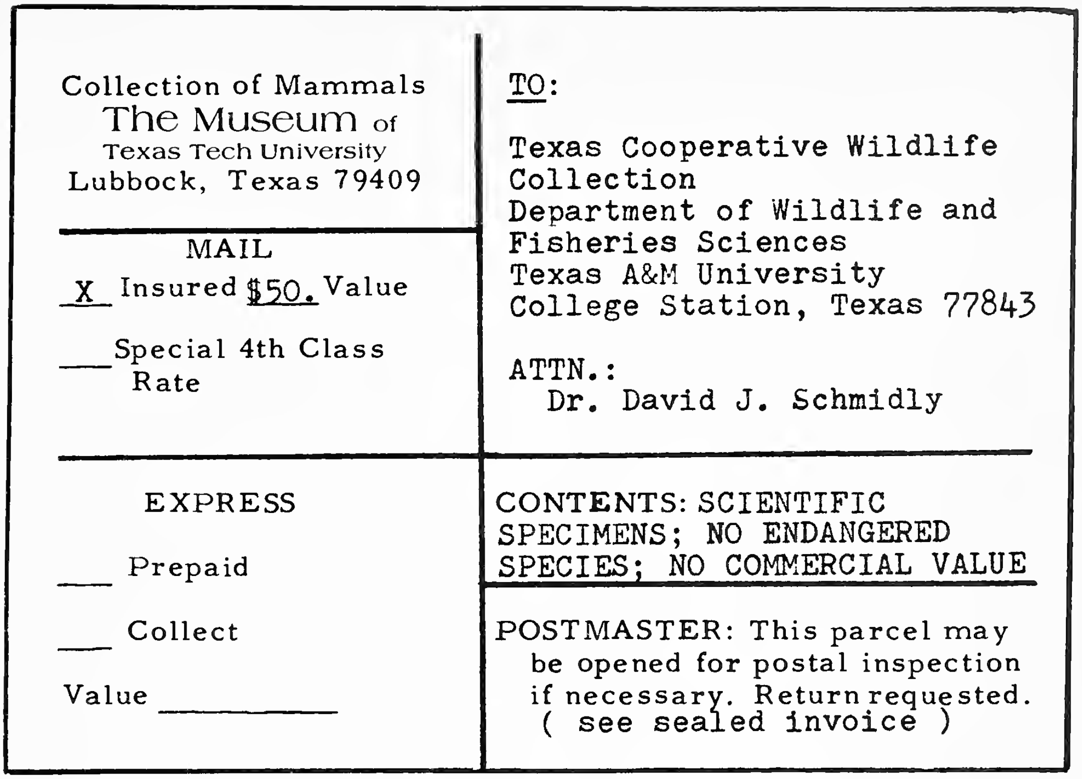
TTU 22961 - 18.6 mi. N., 1.2 mi. E. Marathon-O.K.
" 22965 - 18.5 mi. N., 1.3 mi. E. Marathon-nasals broken anteriorly
" 22966 - " " " -skin without tail
" 22967 - " " " -O.K.
" 22968 - " " " -O.K.

NO ENDANGERED SPECIES; NO COMMERCIAL VALUE

UPON RECEIPT OF SPECIMENS RETURN A SIGNED COPY (YELLOW) OF THE INVOICE. PLEASE REPORT ANY SPECIMEN DAMAGE IMMEDIATELY.

Received: 3 April 1975
Condition: Good except as noted above
David J. Schmidly
SIGNED

Fig. 40. Form used for external loans at Texas Tech University. This form is completed in triplicate. One copy is retained by the loaner, and two copies are sent to the borrower. The borrower signs and returns one copy, and retains one copy for the collection files. Original size was 280 by 217 millimeters.



Collection of Mammals
The Museum of
Texas Tech University
Lubbock, Texas 79409

MAIL
X Insured $50. Value
___ Special 4th Class Rate

EXPRESS
___ Prepaid
___ Collect
Value __________

TO:

Texas Cooperative Wildlife Collection
Department of Wildlife and Fisheries Sciences
Texas A&M University
College Station, Texas 77843

ATTN.:
Dr. David J. Schmidly

CONTENTS: SCIENTIFIC SPECIMENS; NO ENDANGERED SPECIES; NO COMMERCIAL VALUE

POSTMASTER: This parcel may be opened for postal inspection if necessary. Return requested. ( see sealed invoice )

Fig. 41. Label used for mailing a loan of scientific specimens of mammals. Note that the loan is made to an institution and not an individual. Original size of label was 102 by 141 millimeters.

costs are usually paid by the lending institution. The borrower, of course, pays these expenses when returning the material. Shipments valued above $200.00 (the maximum allowable postal insurance per container) should be sent registered mail, private carrier, or in several smaller containers, if possible. If a shipment is sent as registered mail, it can be insured for over $200.00 and such shipments have greater security. The carrier should be notified immediately if insured shipments are damaged enroute. Institutions (for example, ROM, MHP, VMKSC, and TTU) normally insure individual specimens for at least $5.00. This should probably be a base figure, whereas very valuable specimens should probably not be loaned at all. Size of shipment, destination, number of specimens, and nature of the specimens are factors to be considered for insurance purposes. If a shipment is sent to a country outside of the United States, the Postal Service should be consulted about necessary forms and differences in insuring, wrapping, and labeling procedures. In addition, state and federal regulations of the United States should be considered and followed for all exported and imported shipments. Generally, such shipments require appropriate permits, federal inspection, and appropriate forms (for example, Form 3-177—Declaration for Importation of Wildlife; and Form 7523 — Entry and Manifest of Merchandise Free of Duty, Carrier's Certificate and Release — Figs. 42 and 43, respectively). For more detail, see Genoways and Choate (1976) or the Federal Register (for example, CFR 50.10, 50.13, 50.14, 50.17, 50.18, and 50.216).

Specimens must be packed in such a manner as to protect them from shock and excessive heat or moisture. Packing facilities should ideally be located near collection storage areas. Crates should be of wood, with a wooden lid that is screwed rather than nailed in place (Keck, 1970). Packing of research specimens is of necessity a rather slow process. Cotton, paper, excelsior, straw, and other materials have classically been utilized for this purpose. Today, a host of excellent, industrial synthetic packing materials (for example, polyethylene foam) is available (Fall, 1965; Long, 1970). Packing materials should be non-abrasive, non-staining, non-linting, strong, lightweight, resilient, and water, mold, and flame resistant (Fall, 1965).

U.S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
Washington, D. C. 20240

Form Approved
Budget Bureau No. 42-R1476

DECLARATION FOR IMPORTATION OF WILDLIFE
(50 CFR 13.12)

INSTRUCTIONS: Submit original and copy to Collector of Customs, at the port of entry where inspection occurs.

| Name of Importer | Address (Street, city, state, and zip code) |
|---|---|
| Name of Broker (If any) | Address (Street, city, state, and zip code) |
| Name of Consignor | Address (Street, city, state, and zip code) |

List below by species, giving number imported with common and scientific names of each. Continue on reverse side, if necessary.

| NUMBER | COMMON NAME | SCIENTIFIC NAME |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
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| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Signature of Importer or Broker | Date submitted

CUSTOMS OFFICER

Port of Entry | Signature | Date

Form 3-177
(August 1965)

★ Bureau of Customs: Mail originals at the end of the month to: Director, Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, Washington, D. C. 20240

GPO : 1965 O—793-320

Fig. 42. U.S. Department of the Interior Form 3-177—Declaration for Importation of Wildlife. This form must be completed at least in duplicate with each importation or exportation of scientific specimens of mammals.

DEPARTMENT OF THE TREASURY
U. S. CUSTOMS SERVICE
6.1, 8.51a, C.R.; 6.1, 8.51a C.M.

Form approved
O.M.B. No. 48-R0461

## ENTRY AND MANIFEST OF MERCHANDISE FREE OF DUTY, CARRIER'S CERTIFICATE AND RELEASE

PREPARE IN DUPLICATE

No.____________

The undersigned, as the importer of merchandise described below, which arrived at the port or station identified, hereby claims free entry therefor under the provisions of the applicable law indicated.

| DISTRICT NO. | PORT OR STATION | DATE |
|---|---|---|
| | | |

| VESSEL OR OTHER CONVEYANCE | ARRIVAL DATE | COUNTRY OF EXPORTATION |
|---|---|---|
| | | |

| MARKS AND NUMBERS | DESCRIPTION AND QUANTITY OF MERCHANDISE | VALUE | T.S.U.S. ITEM OR P.L. NO |
|---|---|---|---|
| | | | |

| IMPORTER *(Name and Address)* | AGENT'S SIGNATURE |
|---|---|
| | |

INSPECTED AND PASSED FREE OF DUTY BY:

| SIGNATURE *(Inspector)* | DATE |
|---|---|
| | |

### CARRIER'S CERTIFICATE AND RELEASE ORDER

The undersigned carrier, to whom or upon whose order the articles described above must be released, hereby certifies that the person or firm named above as the importer is the owner or consignee of such articles within the purview of section 484 (h), Tariff Act of 1930. In accordance with the provisions of section 484 (j), Tariff Act of 1930, authority is hereby given to release the articles to such consignee.

| CARRIER | AGENT'S SIGNATURE |
|---|---|
| | |

Duplicate copy shall be sent weekly on Friday to the Import Statistics Section, Foreign Trade Division, Bureau of the Census, Washington, D.C. 20233

(This form may be printed by private parties provided it conforms to official form in size, wording, arrangement, and quality and color of paper.)

GPO 953-573 Customs Form 7523 (11-2-73)

Fig. 43. U.S. Customs Form 7523—Entry and Manifest of Merchandise Free of Duty, Carrier's Certificate and Release. This must be completed at least in duplicate when importing scientific specimens.

Skulls and skeletal material must be protected from breakage. Containers (for example, vials and boxes) for skeletal material must be padded inside to prevent damage to the contents. Padding material may be tissue paper or cotton. However, cotton is less desirable because skeletal parts may become entangled or lost in such material. Containers for skeletal material, particularly vials, should be individually wrapped in paper to help prevent breakage and loss or mixing of skeletal material if breakage occurs. Hoffmeister (1973) suggests using Styrofoam blocks for protecting vials. In the case of large skulls, resilient material should be placed between teeth to prevent chipping. Specimens must not be crowded together, as damage may result. Layers of specimens should be separated by padding.

Fluid-preserved material should be wrapped in cheesecloth moistened with the appropriate fluid to prevent dessication and subsequently placed and sealed in several plastic bags (Fall, 1965; Quay, 1974). Further protection calls for the wrapped specimens to be placed in a metal can with airtight lids. Data sheets must be included with alcoholic specimens that lack such tags. The loan material should then be packed in a wooden box of appropriate size (American Society of Mammalogists, 1974). It is recommended that the top of such boxes be marked for unpacking purposes. Wooden boxes are reusable more often when covered with wrapping paper before addressing. Sturdy twine should encircle the wrapping paper as well.

If possible, original packing materials should be reused when repacking a loan for return. Care must be exercised when unpacking shipments. Specimens may inadvertently be discarded with the packing material.

Prior to return of the material by the borrower, a letter announcing the subsequent return of the specimens should be sent to the loaning institution. At this time, the borrower should include in the shipment a self-addressed postcard, which the loaning institution should return, notifying of safe arrival and satisfactory condition of the shipment. It is also possible to request a "receipt of delivery" notice from the receiver, via the postal service. Upon receipt of the specimens, the lender must ascertain the condition of the material and return the enclosed self-addressed postcard to the borrower. The transaction is completed when the invoice is "closed" and the specimens have been properly returned to their storage areas, following fumigation. All packing materials should be removed from the specimens prior to their reinstallation, at which time loan slips are removed.

Complete records of loan transactions should be kept on file. Such documentation includes copies of the initial request and authorization, specimen invoice, inventory receipt of borrower (a copy of invoice returned to lender), lender's return acknowledgement, carrier's receipts, and insurance records.

## CONCLUSION

Over the past several years, acquisition of specimens, as well as equipment and supplies, has, in many instances, become increasingly difficult. International, national, state, and local legislation, intimately affecting all our endeavors, has become more prevalent and complex. Mammalogy as a discipline is compelled to develop the most efficient, economical, and responsible management procedures possible under these circumstances.

We have attempted in this manual to consolidate the existing literature, the thoughtful and knowledgeable suggestions of professionals in the field, and our own philosophies regarding standardizing major aspects of collection management. A great deal of research into curatorial techniques still remains to be done. We hope that this preliminary work represents progress in that direction. It has likewise been our goal throughout this paper to relay "the museum conscience" so eloquently stated by Joseph Grinnell (1922).

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APPENDIX A: Two methods for arrangement of collections of Recent mammals based on Simpson (1945) with recent taxonomic changes. The left column follows Simpson's arrangement of living mammals to the subfamilial level, the genera being arranged alphabetically. The right column follows Simpson's arrangement to the generic level.

Class MAMMALIA
Order MONOTREMATA
F. Tachyglossidae
G. *Tachyglossus*
*Zaglossus*
F. Ornithorhynchidae
G. *Ornithorhynchus*
Order MARSUPIALIA
F. Didelphidae
SF. Microbiotheriinae
G. *Caluromys*
*Caluromysiops*
SF. Didelphinae
G. *Chironectes*
*Didelphis*
*Dromiciops*
*Glironia*
*Lestodelphis*
*Lutreolina*
*Marmosa*
*Metachirops*
*Metachirus*
*Monodelphis*
*Notodelphis*
*Philander*
F. Dasyuridae
SF. Phascogalinae
G. *Antechinomys*
*Antechinus*
*Dasycercus*
*Dasyuroides*
*Murexia*
*Myoictis*
*Neophascogale*
*Parantechinus*
*Phascogale*
*Phascolosorex*
*Planigale*
*Pseudoantechinus*
*Sminthopsis*
SF. Dasyurinae
G. *Dasyurinus*
*Dasyurops*
*Dasyurus*
*Sarcophilus*
*Satanellus*
SF. Thylacininae
G. *Thylacinus*
SF. Myrmecobiinae
G. *Myrmecobius*
F. Notoryctidae
G. *Notoryctes*

Class MAMMALIA
Order MONOTREMATA
F. Tachglossidae
G. *Tachyglossus*
*Zaglossus*
F. Ornithorhychidae
G. *Ornithorhychus*
Order MARSUPIALIA
F. Didelphidae
SF. Microbiotheriinae
G. *Caluromys*
*Caluromysiops*
SF. Didelphinae
G. *Monodelphis*
*Dromiciops*
*Glironia*
*Notodelphis*
*Lestodelphis*
*Marmosa*
*Metachirops*
*Metachirus*
*Philander*
*Lutreolina*
*Didelphis*
*Chironectes*
F. Dasyuridae
SF. Phascogalinae
G. *Phascogale*
*Antechinus*
*Planigale*
*Murexia*
*Neophascogale*
*Parantechinus*
*Phascolosorex*
*Pseudoantechinus*
*Myoictis*
*Dasyuroides*
*Dasycercus*
*Sminthopsis*
*Antechinomys*
SF. Dasyurinae
G. *Dasyurus*
*Dasyurinus*
*Satanellus*
*Dasyurops*
*Sarcophilus*
SF. Thylacininae
G. *Thylacinus*
SF. Myrmecobiinae
G. *Myrmecobius*
F. Notoryctidae
G. *Notoryctes*

F. Peramelidae
G. *Chaeropus*
*Echymipera*
*Isoodon*
*Microperoryctes*
*Perameles*
*Peroryctes*
*Rhynchomeles*
*Thylacis*
*Thylacomys*
F. Caenolestidae
SF. Caenolestinae
G. *Caenolestes*
*Lestoros*
*Orolestes*
*Rhyncholestes*
F. Phalangeridae
SF. Phalangerinae
G. *Acrobates*
*Cercartetus*
*Dactylonax*
*Dactylopsila*
*Distoechurus*
*Eudromicia*
*Gymnobelideus*
*Petaurus*
*Phalanger*
*Spilocuscus*
*Trichosurus*
*Wyulda*
SF. Tarsipedinae
G. *Tarsipes*
SF. Phascolarctinae
G.*Hemibelideus*
*Phascolarctos*
*Petropseudes*
*Pseudocheirus*
*Schoinobates*
Sf. Burramyinae
G. *Burramys*
F. Phascolomidae
G. *Lasiorhinus*
*Phascolomis*
*Wombatula*
F. Macropodidae
SF. Macropodinae
G. *Dendrolagus*
*Dorcopsis*
*Dorcopsulus*
*Lagorchestes*
*Lagostrophus*
*Macropus*
*Onychogalea*
*Peradorcas*
*Petrogale*
*Protemnodon*
*Setonix*
*Thylogale*
*Wallabia*
SF. Potoroinae
G. *Aepyprymnus*
*Bettongia*

F. Peramelidae
G. *Perameles*
*Peroryctes*
*Thylacis*
*Microperoryctes*
*Echymipera*
*Thylacomys*
*Chaeropus*
*Isoodon*
*Rhynchomeles*
F. Caenolestidae
SF. Caenolestinae
G. *Caenolestes*
*Lestoros*
*Orolestes*
*Rhyncholestes*
F. Phalangeridae
SF. Phalangerinae
G. *Phalanger*
*Trichosurus*
*Acrobates*
*Distoechurus*
*Cercartetus*
*Eudromicia*
*Gymnobelideus*
*Petaurus*
*Dactylopsila*
*Dactylonax*
*Wyulda*
*Spilocuscus*
SF. Tarsipedinae
G. *Tarsipes*
SF. Phascolarctinae
G. *Phascolarctos*
*Pseudocheirus*
*Hemibelideus*
*Petropseudes*
*Schoinobates*
SF. Burramyinae
G. *Burramys*
F. Phascolomidae
G. *Phascolomis*
*Lasiorhinus*
*Wombatula*
F. Macropodidae
SF. Macropodinae
G. *Lagorchestes*
*Lagostrophus*
*Petrogale*
*Peradorcus*
*Onychogalea*
*Thylogale*
*Protemnodon*
*Wallabia*
*Macropus*
*Setonix*
*Dendrolagus*
*Dorcopsis*
*Dorcopsulus*
SF. Potoroinae
G. *Bettongia*
*Aepyprymnus*

*Caloprymnus*
*Hypsiprymnodon*
*Potorous*

Order INSECTIVORA
F. Solenodontidae
SF. Solenodontinae
G. *Solenodon*
F. Tenrecidae
SF. Tenrecinae
G. *Dasogale*
*Echinops*
*Hemicentetes*
*Setifer*
*Tenrec*
SF. Oryzorictinae
G. *Cryptogale*
*Geogale*
*Limnogale*
*Microgale*
*Oryzorictes*
F. Potamogalidae
G. *Micropotamogale*
*Potamogale*
F. Chrysochloridae
G. *Amblysomus*
*Chlorotalpa*
*Chrysochloris*
*Chrysospalax*
*Cryptochloris*
*Eremitalpa*
F. Erinaceidae
SF. Echinosoricinae
G. *Echinosorex*
*Hylomys*
*Neohylomys*
*Neotetracus*
*Podogymnura*
SF.Erinaceinae
G. *Aethechinus*
*Atelerix*
*Erinaceus*
*Hemiechinus*
*Paraechinus*
F. Macroscelididae
G. *Elephantulus*
*Macroscelides*
*Nasilio*
*Petrodromus*
*Rhynchocyon*
F. Soricidae
SF. Soricinae
G. *Blarina*
*Blarinella*
*Cryptotis*
*Megasorex*
*Microsorex*
*Neomys*
*Notiosorex*
*Podihik*
*Sorex*
*Soriculus*
SF. Crocidurinae

*Caloprymnus*
*Potorous*
*Hypsiprymnodon*

Order INSECTIVORA
F. Solenodontidae
SF. Solenodontinae
G. *Solenodon*
F. Tenrecidae
SF. Tenrecinae
G. *Tenrec*
*Setifer*
*Hemicentetes*
*Dasogale*
*Echinops*
SF. Oryzorictinae
G. *Oryzorictes*
*Microgale*
*Cryptogale*
*Limnogale*
*Geogale*
F. Potamogalidae
G. *Potamogale*
*Micropotamogale*
F. Chrysochloridale
G. *Chrysochloris*
*Eremitalpa*
*Amblysomus*
*Chlorotalpa*
*Chrysospalax*
*Cryptochloris*
F. Erinaceidae
SF. Echinosoricinae
G. *Echinsorex*
*Hylomys*
*Neohylomys*
*Podogymnura*
*Neotetracus*
SF. Erinaceinae
G. *Aethechinus*
*Erinaceus*
*Atelerix*
*Hemiechinus*
*Paraechinus*
F. Macroscelididae
G. *Macroscelides*
*Nasilio*
*Elephantulus*
*Petrodromus*
*Rhynchocyon*
F. Soricidae
SF. Soricinae
G. *Sorex*
*Microsorex*
*Soriculus*
*Podihik*
*Neomys*
*Blarina*
*Blarinella*
*Cryptotis*
*Notiosorex*
*Megasorex*
SF. Crocidurinae

G. *Anourosorex*
*Chimarrogale*
*Crocidura*
*Diplomesodon*
*Feroculus*
*Myosorex*
*Nectogale*
*Paracrocidura*
*Praesorex*
*Solisorex*
*Suncus*
*Surdisorex*
*Sylvisorex*
SF. Scutisoricinae
G. *Scutisorex*
F. Talpidae
SF. Uropsilinae
G. *Nasillus*
*Uropsilus*
SF. Desmaninae
G. *Desmana*
*Galemys*
SF. Talpinae
G. *Mogera*
*Parascaptor*
*Scaptochirus*
*Talpa*
SF. Scalopinae
G. *Dymecodon*
*Neurotrichus*
*Parascalops*
*Scalopus*
*Scapanulus*
*Scapanus*
*Scaptonyx*
*Urotrichus*
SF. Condylurinae
G. *Condylura*
Order DERMOPTERA
F. Cynocephalidae
G. *Cynocephalus*
Order CHIROPTERA
F. Pteropidae
SF. Pteropinae
G. *Acerodon*
*Aethalops*
*Balionycteris*
*Boneia*
*Casinycteris*
*Chironax*
*Cynonycteris*
*Cynopterus*
*Dobsonia*
*Dyacopterus*
*Eidolon*
*Epomophorus*
*Epomops*
*Haplonycteris*
*Hypsignathus*
*Lissonycteris*
*Megaerops*

G. *Crocidura*
*Paracrocidura*
*Praesorex*
*Suncus*
*Feroculus*
*Solisorex*
*Sylvisorex*
*Myosorex*
*Surdisorex*
*Diplomesodon*
*Anourosorex*
*Chimarrogale*
*Nectogale*
SF. Scutisoricinae
G. *Scutisorex*
F. Talpidae
SF. Uropsilinae
G. *Uropsilus*
*Nasillus*
SF. Desmaninae
G. *Desmana*
*Galemys*
SF. Talpinae
G. *Talpa*
*Mogera*
*Parascaptor*
*Scaptochirus*
SF. Scalopinae
G. *Scaptonyx*
*Dymecodon*
*Neurotrichus*
*Urotrichus*
*Scapanulus*
*Parascalops*
*Scapanus*
*Scalopus*
SF. Condylurinae
G. *Condylura*
Order DERMOPTERA
F. Cynocephalidae
G. *Cynocephalus*
Order CHIROPTERA
F. Pteropidae
SF. Pteropinae
G. *Cynopterus*
*Niadius*
*Thoopterus*
*Chironax*
*Dyacopterus*
*Penthetor*
*Sphaerias*
*Ptenochirus*
*Megaerops*
*Balionycteris*
*Rousettus*
*Cynonycteris*
*Myonycteris*
*Lissonycteris*
*Pteropus*
*Neopteryx*
*Acerodon*

*Micropteropus*
*Myonycteris*
*Nanonycteris*
*Neopteryx*
*Niadius*
*Penthetor*
*Plerotes*
*Ptenochirus*
*Pteralopex*
*Pteropus*
*Rousettus*
*Scotonycteris*
*Sericonycteris*
*Sphaerias*
*Styloctenium*
*Thoopterus*
SF. Macroglossinae
G. *Callinycteris*
*Eonycteris*
*Macroglossus*
*Megaloglossus*
*Melonycteris*
*Nesonycteris*
*Notopteris*
*Odontonycteris*
*Syconycteris*
SF. Nyctimeninae
G. *Nyctimene*
*Paranyctimene*
SF. Harpyionycterinae
G. *Harpyionycteris*
F. Rhinopomatidae
G. *Rhinopoma*
F. Emballonuridae
SF. Emballonurinae
G. *Balantiopteryx*
*Centronycteris*
*Coleura*
*Cormura*
*Emballonura*
*Liponycteris*
*Myropteryx*
*Peronymus*
*Peropteryx*
*Rhynchonycteris*
*Saccopteryx*
*Taphozous*
SF. Diclidurinae
G. *Cyttarops*
*Depanycteris*
*Diclidurus*
F. Noctilionidae
G. *Noctilio*
F. Nycteridae
G. *Nycteris*
F. Megadermatidae
G. *Lavia*
*Macroderma*
*Megaderma*
F. Rhinolophidae
G. *Rhinolophus*
*Rhinomegalophus*

*Pteralopex*
*Sericonycteris*
*Aethalops*
*Boneia*
*Styloctenium*
*Dobsonia*
*Haplonycteris*
*Epomophorus*
*Epomops*
*Hypsignathus*
*Scotonycteris*
*Micropteropus*
*Nanonycteris*
*Plerotes*
*Casinycteris*
*Eidolon*
SF. Macroglossinae
G. *Eonycteris*
*Callinycteris*
*Macroglossus*
*Odontonycteris*
*Syconycteris*
*Megaloglossus*
*Melonycteris*
*Nesonycteris*
*Notopteris*
SF. Nyctimeninae
G. *Nyctimene*
*Paranyctimene*
SF. Harpyionycterinae
G. *Harpyionycteris*
F. Rhinopomatidae
G. *Rhinopoma*
F. Emballonuridae
SF. Emballonurinae
G. *Emballonura*
*Coleura*
*Rhynchonycteris*
*Saccopteryx*
*Cormura*
*Peropteryx*
*Peronymus*
*Centronycteris*
*Balantiopteryx*
*Myropteryx*
*Taphozous*
*Liponycteris*
SF. Diclidurinae
G. *Cyttarops*
*Depanycteris*
*Diclidurus*
F. Noctilionidae
G. *Noctilio*
F. Nycteridae
G. *Nycteris*
F. Megadermatidae
G. *Megaderma*
*Macroderma*
*Lavia*
F. Rhinolophidae
G. *Rhinolophus*
*Rhinomegalophus*

F. Hipposideridae
SF. Hipposiderinae
G. *Anthops*
*Asellia*
*Aselliscus*
*Cloeotis*
*Coelops*
*Hipposideros*
*Paracoelops*
*Rhinonicteris*
*Triaenops*
F. Mormoopidae
G. *Mormoops*
*Pteronotus*
F. Phyllostomatidae
SF. Phyllostomatinae
G. *Chrotopterus*
*Lonchorhina*
*Macrophyllum*
*Macrotus*
*Micronycteris*
*Mimon*
*Phylloderma*
*Phyllostomus*
*Tonatia*
*Trachops*
*Vampyrum*
SF. Glossophaginae
G. *Anoura*
*Choeroniscus*
*Choeronycteris*
*Glossophaga*
*Hylonycteris*
*Leptonycteris*
*Lichonycteris*
*Lionycteris*
*Lonchophylla*
*Monophyllus*
*Musonycteris*
*Platalina*
*Scleronycteris*
SF. Carolliinae
G. *Carollia*
*Rhinophylla*
SF. Stenoderminae
G. *Ametrida*
*Ardrops*
*Ariteus*
*Artibeus*
*Centurio*
*Chiroderma*
*Corvira*
*Ectophylla*
*Enchisthenes*
*Mesophylla*
*Phyllops*
*Pygoderma*
*Sphaeronycteris*
*Stenoderma*
*Sturnira*
*Uroderma*
*Vampyressa*

F. Hipposideridae
SF. Hipposiderinae
G. *Hipposideros*
*Anthops*
*Asellia*
*Aselliscus*
*Coelops*
*Paracoelops*
*Cloeotis*
*Rhinonicteris*
*Triaenops*
F. Mormoopidae
G. *Pteronotus*
*Mormoops*
F. Phyllostomatidae
SF. Phyllostomatinae
G. *Micronycteris*
*Macrotus*
*Lonchorhina*
*Macrophyllum*
*Tonatia*
*Mimon*
*Phyllostomus*
*Phylloderma*
*Trachops*
*Chrotopterus*
*Vampyrum*
SF. Glossophaginae
G. *Glossophaga*
*Lionycteris*
*Lonchophylla*
*Platalina*
*Monophyllus*
*Anoura*
*Musonycteris*
*Choeronycteris*
*Choeroniscus*
*Scleronycteris*
*Hylonycteris*
*Leptonycteris*
*Lichonycteris*
SF. Carolliinae
G. *Carollia*
*Rhinophylla*
SF. Stenoderminae
G. *Uroderma*
*Vampyrops*
*Vampyrodes*
*Vampyressa*
*Vampyriscus*
*Chiroderma*
*Ectophylla*
*Mesophylla*
*Artibeus*
*Enchisthenes*
*Sturnira*
*Corvira*
*Stenoderma*
*Ariteus*
*Phyllops*
*Ardops*
*Pygoderma*

*Vampyriscus*
*Vampyrodes*
*Vampyrops*
SF. Phyllonycterinae
G. *Brachyphylla*
*Erophylla*
*Phyllonycteris*
SF. Desmodontinae
G. *Desmodus*
*Diaemus*
*Diphylla*
F. Natalidae
G. *Natalus*
F. Furipteridae
G. *Amorphochilus*
*Furipterus*
F. Thyropteridae
G. *Thyroptera*
F. Myzopodidae
G. *Myzopoda*
F. Vespertilionidae
SF. Vespertilioninae
G. *Baeodon*
*Barbastella*
*Chalinolobus*
*Cistugo*
*Eptesicus*
*Euderma*
*Eudiscopus*
*Glauconycteris*
*Glischropus*
*Hesperoptenus*
*Histiotus*
*Idionycteris*
*Laephotis*
*Lasionycteris*
*Lasiurus*
*Mimetillus*
*Myotis*
*Nyctalus*
*Nycticeius*
*Otonycteris*
*Philetor*
*Pipistrellus*
*Pizonyx*
*Plecotus*
*Rhinopterus*
*Rhogeessa*
*Scotomanes*
*Scotophilus*
*Tylonycteris*
*Vespertilio*
SF. Miniopterinae
G. *Miniopterus*
SF. Murininae
G. *Harpiocephalus*
*Murina*
SF. Kerivoulinae
G. *Kerivoula*
SF. Nyctophilinae
G. *Antrozous*
*Nyctophilus*

*Centurio*
*Ametrida*
*Sphaeronycteris*
SF. Phyllonycterinae
G. *Brachyphylla*
*Phyllonycteris*
*Erophylla*
SF. Desmodontinae
G. *Desmodus*
*Diaemus*
*Diphylla*
F. Natalidae
G. *Natalus*
F. Furipteridae
G. *Furipterus*
*Amorphochilus*
F. Thyropteridae
G. *Thyroptera*
F. Myzopodidae
G. *Myzopoda*
F. Vespertilionidae
SF. Vespertilioninae
G. *Myotis*
*Pizonyx*
*Lasionycteris*
*Pipistrellus*
*Glischropus*
*Nyctalus*
*Eudiscopus*
*Eptesicus*
*Rhinopterus*
*Hesperoptenus*
*Tylonycteris*
*Mimetillus*
*Philetor*
*Histiotus*
*Laephotis*
*Vespertilio*
*Otonycteris*
*Nycticeius*
*Scotomanes*
*Rhogeessa*
*Baeodon*
*Scotophilus*
*Chalinolobus*
*Glauconycteris*
*Cistugo*
*Lasiurus*
*Barbastella*
*Plecotus*
*Idionycteris*
*Euderma*
SF. Miniopterinae
G. *Miniopterus*
SF. Murininae
G. *Murina*
*Harpiocephalus*
SF. Kerivoulinae
G. *Kerivoula*
SF. Nyctophilinae
G. *Antrozous*
*Nyctophilus*

*Pharotis*
SF. Tomopeatinae
G. *Tomopeas*
F. Mystacinidae
G. *Mystacina*
*F. Molossidae*
*G. Cheiromeles*
*Eomops*
*Eumops*
*Molossops*
*Molossus*
*Mops*
*Mormopterus*
*Neoplatymops*
*Otomops*
*Platymops*
*Promops*
*Tadarida*
*Xiphonycteris*
Order PRIMATES
F. Tupaiidae
SF. Tupaiinae
G. *Anathana*
*Dendrogale*
*Tana*
*Tupaia*
*Urogale*
SF. Ptilocercinae
G. *Ptilocercus*
F. Lemuridae
SF. Lemurinae
G. *Hapalemur*
*Lemur*
*Lepilemur*
SF. Cheirogaleinae
G. *Cheirogaleus*
*Microcebus*
*Phaner*
F. Indridae
G. *Avahi*
*Indri*
*Prophithecus*
F. Daubentoniidae
G. *Daubentonia*
F. Lorisidae
SF. Lorisinae
G. *Arctocebus*
*Loris*
*Nycticebus*
*Perodicticus*
SF. Galaginae
G. *Euoticus*
*Galago*
F. Tarsiidae
G. *Tarsius*
F. Cebidae
SF. Aotinae
G. *Aotes*
*Callicebus*
SF. Pitheciinae
G. *Cacajao*
*Chiropotes*

*Pharotis*
SF. Tomopeatinae
G. *Tomopeas*
F. Mystacinidae
G. *Mystacina*
*F. Molossidae*
G. *Eomops*
*Molossops*
*Cheiromeles*
*Xiphonycteris*
*Tadarida*
*Mops*
*Mormopterus*
*Platymops*
*Neoplatymops*
*Otomops*
*Molossus*
*Promops*
*Eumops*
Order PRIMATES
F. Tupaiidae
SF. Tupaiinae
G. *Tupaia*
*Anathana*
*Dendrogale*
*Tana*
*Urogale*
SF. Ptilocercinae
G. *Ptilocercus*
F. Lemuridae
SF. Lemurinae
G. *Hapalemur*
*Lemur*
*Lepilemur*
SF. Cheirogaleinae
G. *Cheirogaleus*
*Microcebus*
*Phaner*
F. Indridae
G. *Avahi*
*Indri*
*Propithecus*
F. Daubentoniidae
G. *Daubentonia*
F. Lorisidae
SF. Lorisinae
G. *Loris*
*Nycticebus*
*Arctocebus*
*Perodicticus*
SF. Galaginae
G. *Galago*
*Euoticus*
F. Tarsiidae
G. *Tarsius*
F. Cebidae
SF. Aotinae
G. *Aotes*
*Callicebus*
SF. Pitheciinae
G. *Cacajao*
*Pithecia*

*Pithecia*
SF. Alouattinae
G. *Alouatta*
SF. Cebinae
G. *Cebus*
*Saimiri*
SF. Atelinae
G. *Ateles*
*Brachyteles*
*Lagothrix*
SF. Callimiconinae
G. *Callimico*
F. Callithricidae
G. *Callithrix*
*Cebuella*
*Leontideus*
*Saguinus*
F. Cercopithecidae
SF. Cercopithecinae
G. *Allenopithecus*
*Cercocebus*
*Cercopithecus*
*Chaeorpithecus*
*Comopithecus*
*Cynomacaca*
*Cynopithecus*
*Erythrocebus*
*Macaca*
*Mandrillus*
*Miopithecus*
*Papio*
*Theropithecus*
SF. Colobinae
G. *Colobus*
*Nasalis*
*Presbytis*
*Pygathrix*
*Rhinopithecus*
*Simias*
F. Pongidae
SF. Hylobatinae
G. *Hylobates*
*Symphalangus*
SF. Ponginae
G. *Gorilla*
*Pan*
*Pongo*
F. Hominidae
G. *Homo*
Order EDENTATA
F. Myrmecophagidae
G. *Cyclopes*
*Myrmecophaga*
*Tamandua*
F. Bradypodidae
G. *Bradypus*
*Choleopus*
F. Dasypodidae
SF. Dasypodinae
G. *Cabassous*
*Chaetophractus*
*Dasypus*

*Chiropotes*
SF. Alouattinae
G. *Alouatta*
SF. Cebinae
G. *Cebus*
*Saimiri*
SF. Atelinae
G. *Ateles*
*Brachyteles*
*Lagothrix*
SF. Callimiconinae
G. *Callimico*
F. Callithricidae
G. *Callithrix*
*Cebuella*
*Saguinus*
*Leontideus*
F. Cercopithecidae
SF. Cercopithecinae
G. *Macaca*
*Cynomacaca*
*Cynopithecus*
*Cercocebus*
*Papio*
*Chaeropithecus*
*Comopithecus*
*Mandrillus*
*Theropithecus*
*Cercopithecus*
*Miopithecus*
*Allenopithecus*
*Erythocebus*
SF. Colobinae
G. *Presbytis*
*Pygathrix*
*Rhinopithecus*
*Simias*
*Nasalis*
*Colobus*
F. Pongidae
SF. Hylobatinae
G. *Hylobates*
*Symphalangus*
SF. Ponginae
G. *Pongo*
*Pan*
*Gorilla*
F. Hominidae
G. *Homo*
Order EDENTATA
F. Myrmecophagidae
G. *Myrmecophaga*
*Tamandua*
*Cyclopes*
F. Bradypodidae
G. *Bradypus*
*Choleopus*
F. Dasypodidae
SF. Dasypodinae
G. *Chaetophractus*
*Euphractus*
*Zaedyus*

*Euphractus*
*Priodontes*
*Tolypeutes*
*Zaedyus*
SF. Chlamyphorinae
G. *Burmeisteria*
*Chlamyphorus*
Order PHOLIDOTA
F. Manidae
G. *Manis*
Order LAGOMORPHA
F. Ochotonidae
G. *Ochotona*
F. Leporidae
SF. Palaeolaginae
G. *Pentalagus*
*Pronolagus*
*Romerolagus*
SF. Leporinae
G. *Brachylagus*
*Caprolagus*
*Lepus*
*Nesolagus*
*Oryctolagus*
*Poelagus*
*Sylvilagus*
Order RODENTIA
F. Aplodontidae
G. *Aplodontia*
F. Sciuridae
SF. Sciurinae
G. *Ammospermophilus*
*Atlantoxerus*
*Callosciurus*
*Cynomys*
*Dremomys*
*Epixerus*
*Eutamias*
*Euxerus*
*Exilisciurus*
*Funambulus*
*Funisciurus*
*Geosciurus*
*Glyphotes*
*Heliosciurus*
*Hyosciurus*
*Lariscus*
*Marmota*
*Menetes*
*Microsciurus*
*Myosciurus*
*Nannosciurus*
*Paraxerus*
*Prosciurillus*
*Protoxerus*
*Ratufa*
*Rheithrosciurus*
*Rhinosciurus*
*Sciurillus*
*Sciurotamias*
*Sciurus*
*Spermophilopsis*

*Priodontes*
*Cabassous*
*Tolypeutes*
*Dasypus*
SF. Chlamyphorinae
G. *Chlamyphorus*
*Burmeisteria*
Order PHOLIDOTA
F. Manidae
G. *Manis*
Order LAGOMORPHA
F. Ochotonidae
G. *Ochotona*
F. Leporidae
SF. Palaeolaginae
G. *Pentalagus*
*Pronolagus*
*Romerolagus*
SF. Leporinae
G. *Caprolagus*
*Lepus*
*Poelagus*
*Sylvilagus*
*Oryctolagus*
*Brachylagus*
*Nesolagus*
Order RODENTIA
F. Aplodontidae
G. *Aplodontia*
F. Sciuridae
SF. Sciurinae
G. *Sciurus*
*Syntheosciurus*
*Mircosciurus*
*Sciurillus*
*Prosciurillus*
*Rheithrosciurus*
*Tamiasciurus*
*Funambulus*
*Ratufa*
*Protoxerus*
*Epixerus*
*Funisciurus*
*Paraxerus*
*Heliosciurus*
*Hyosciurus*
*Myosciurus*
*Callosciurus*
*Tamiops*
*Sundasciurus*
*Menetes*
*Rhinosciurus*
*Lariscus*
*Dremomys*
*Sciurotamias*
*Glyphotes*
*Nannosciurus*
*Exilisciurus*
*Atlantoxerus*
*Xerus*
*Euxerus*
*Geosciurus*

*Spermophilus*
*Sundasciurus*
*Syntheosciurus*
*Tamias*
*Tamiasciurus*
*Tamiops*
*Xerus*
SF. Petauristinae
G. *Aeretes*
*Aeromys*
*Belomys*
*Eoglaucomys*
*Eupetaurus*
*Glaucomys*
*Hylopetes*
*Iomys*
*Petaurillus*
*Petaurista*
*Petinomys*
*Pteromys*
*Pteromyscus*
*Sciuropterus*
*Trogopterus*
F. Geomyidae
SF. Geomyinae
G. *Geomys*
*Orthogeomys*
*Pappogeomys*
*Thomomys*
*Zygogeomys*
F. Heteromyidae
SF. Perognathinae
G. *Microdipodops*
*Perognathus*
SF. Dipodomyinae
G. *Dipodomys*
SF. Heteromyinae
G. *Heteromys*
*Liomys*
F. Castoridae
SF. Castorinae
G. *Castor*
F. Anomaluridae
SF. Anomalurinae
G. *Anomalurops*
*Anomalurus*
SF. Zenkerellinae
G. *Idiurus*
*Zenkerella*
F. Pedetidae
G. *Pedetes*
F. Cricetidae
SF. Cricetinae
G. *Akodon*
*Andinomys*
*Anotomys*
*Baiomys*
*Blarinomys*
*Calomys*
*Calomyscus*
*Chelemyscus*
*Chilomys*

*Spermophilopsis*
*Marmota*
*Cynomys*
*Spermophilus*
*Ammospermophilus*
*Tamias*
*Eutamias*
SF. Petauristinae
G. *Petaurista*
*Pteromys*
*Aeromys*
*Eupetaurus*
*Sciuropterus*
*Glaucomys*
*Eoglaucomys*
*Hylopetes*
*Petinomys*
*Aeretes*
*Trogopterus*
*Belomys*
*Pteromyscus*
*Petaurillus*
*Iomys*
F. Geomyidae
SF. Geomyinae
G. *Geomys*
*Thomomys*
*Pappogeomys*
*Orthogeomys*
*Zygogeomys*
F. Heteromyidae
SF. Perognathinae
G. *Perognathus*
*Microdipodops*
SF. Dipodomyinae
G. *Dipodomys*
SF. Heteromyinae
G. *Liomys*
*Heteromys*
F. Castoridae
SF. Castorinae
G. *Castor*
F. Anomaluridae
SF. Anomalurinae
G. *Anomalurus*
*Anomalurops*
SF. Zenkerellinae
G. *Idiurus*
*Zenkerella*
F. Pedetidae
G. *Pedetes*
F. Cricetidae
SF. Cricetinae
G. *Oryzomys*
*Megalomys*
*Melanomys*
*Neacomys*
*Scolomys*
*Nectomys*
*Rhipidomys*
*Thomasomys*
*Wilfredomys*

*Chinchillula*
*Cricetulus*
*Cricetus*
*Daptomys*
*Eligomodontia*
*Euneomys*
*Graomys*
*Hesperomys*
*Holochilus*
*Ichtohyomys*
*Irenomys*
*Lenoxus*
*Megalomys*
*Melanomys*
*Mesocricetus*
*Microxus*
*Myospalax*
*Mystromys*
*Neacomys*
*Nectomys*
*Nelsonia*
*Neotoma*
*Neotomodon*
*Neotomys*
*Neusticomys*
*Notiomys*
*Nyctomys*
*Ochrotomys*
*Onychomys*
*Oryzomys*
*Otonyctomys*
*Ototylomys*
*Oxymycterus*
*Peromyscus*
*Phaenomys*
*Phodopus*
*Phyllotis*
*Podoxymys*
*Pseudoryzomys*
*Punomys*
*Reithrodon*
*Reithrodontomys*
*Rhagomys*
*Rheomys*
*Rhipidomys*
*Scapteromys*
*Scolomys*
*Scotinomys*
*Sigmodon*
*Sigmomys*
*Thomasomys*
*Tylomys*
*Wiedomys*
*Wilfredomys*
*Xenomys*
*Zygodontomys*

SF. Nesomyinae
G. *Brachytarsomys*
*Brachyuromys*
*Eliurus*
*Gymnuromys*
*Hypogeomys*

*Phaenomys*
*Chilomys*
*Tylomys*
*Ototylomys*
*Nyctomys*
*Otonyctomys*
*Rhagomys*
*Reithrodontomys*
*Peromyscus*
*Ochrotomys*
*Baiomys*
*Onychomys*
*Akodon*
*Zygodontomys*
*Microxus*
*Podoxymys*
*Lenoxus*
*Oxymycterus*
*Blarinomys*
*Notiomys*
*Scapteromys*
*Scotinomys*
*Calomys*
*Hesperomys*
*Eligmodontia*
*Graomys*
*Wiedomys*
*Pseudoryzomys*
*Phyllotis*
*Irenomys*
*Chinchillula*
*Punomys*
*Neotomys*
*Reithrodon*
*Euneomys*
*Chelemyscus*
*Holochilus*
*Sigmodon*
*Sigmomys*
*Andinomys*
*Neotomodon*
*Neotoma*
*Nelsonia*
*Xenomys*
*Ichthyomys*
*Anotomys*
*Daptomys*
*Rheomys*
*Neusticomys*
*Calomyscus*
*Phodopus*
*Cricetus*
*Cricetulus*
*Mesocricetus*
*Mystromys*
*Myospalax*

SF. Nesomyinae
G. *Macrotarsomys*
*Nesomys*
*Brachytarsomys*
*Eliurus*
*Gymnuromys*

*Macrotarsomys*
*Nesomys*
SF. Lophiomyinae
G. *Lophiomys*
SF. Microtinae
G. *Alticola*
*Anteliomys*
*Arvicola*
*Aschizomys*
*Blanfordimys*
*Clethrionomys*
*Dicrostonyx*
*Dolomys*
*Ellobius*
*Eothenomys*
*Hyperacrius*
*Lagurus*
*Lemmus*
*Microtus*
*Myopus*
*Neofiber*
*Ondatra*
*Phenacomys*
*Pitymys*
*Prometheomys*
*Synaptomys*
SF. Gerbillinae
G. *Ammodillus*
*Brachiones*
*Desmodilliscus*
*Desmodillus*
*Gerbillurus*
*Gerbillus*
*Meriones*
*Monodia*
*Pachyuromys*
*Psammomys*
*Rhombomys*
*Sekeetamys*
*Tatera*
*Taterillus*
F. Spalacidae
G. *Spalax*
F. Rhizomyidae
G. *Cannomys*
*Rhizomys*
*Tachyoryctes*
F. Muridae
SF. Murinae
G. *Acomys*
*Aethomys*
*Ammomys*
*Anisomys*
*Apodemus*
*Apomys*
*Arvicanthis*
*Bandicota*
*Batomys*
*Beamys*
*Carpomys*
*Chiromyscus*
*Coelomys*
*Colomys*

*Hypogeomys*
*Brachyuromys*
SF. Lophiomyinae
G. *Lophiomys*
SF. Microtinae
G. *Dicrostonyx*
*Synaptomys*
*Myopus*
*Lemmus*
*Clethrionomys*
*Aschizomys*
*Eothenomys*
*Anteliomys*
*Alticola*
*Hyperacrius*
*Dolomys*
*Arvicola*
*Ondatra*
*Neofiber*
*Phenacomys*
*Pitymys*
*Blanfordimys*
*Microtus*
*Lagurus*
*Prometheomys*
*Ellobius*
SF. Gerbillinae
G. *Gerbillus*
*Monodia*
*Tatera*
*Taterillus*
*Gerbillurus*
*Desmodillus*
*Desmodilliscus*
*Pachyuromys*
*Ammodillus*
*Meriones*
*Sekeetamys*
*Brachiones*
*Psammomys*
*Rhombomys*
F. Spalacidae
G. *Spalax*
F. Rhizomyidae
G. *Tachyoryctes*
*Rhizomys*
*Cannomys*
F. Muridae
SF. Murinae
G. *Hapalomys*
*Vernaya*
*Vandeleuria*
*Micromys*
*Apodemus*
*Thamnomys*
*Grammomys*
*Carpomys*
*Mindanaomys*
*Batomys*
*Pithecheir*
*Hyomys*
*Conilurus*
*Zyzomys*

*Conilurus*
*Cricetomys*
*Crunomys*
*Dacnomys*
*Dasymys*
*Diomys*
*Echiothrix*
*Eropeplus*
*Golunda*
*Grammomys*
*Gyomys*
*Hadromys*
*Haeromys*
*Hapalomys*
*Hybomys*
*Hylomyscus*
*Hyomys*
*Laomys*
*Leggadina*
*Leimacomys*
*Lemniscomys*
*Leporillus*
*Lophuromys*
*Lorentzimys*
*Macruromys*
*Malacomys*
*Mastacomys*
*Mastomys*
*Maxomys*
*Melasmothrix*
*Melomys*
*Mesembriomys*
*Micromys*
*Millardia*
*Mindanaomys*
*Muriculus*
*Mus*
*Mycteromys*
*Mylomys*
*Myomys*
*Nesokia*
*Nesoromys*
*Nilopegamys*
*Notomys*
*Oenomys*
*Pelomys*
*Pithecheir*
*Pogonomelomys*
*Praomys*
*Pseudomys*
*Pyromys*
*Rattus*
*Rhabdomys*
*Saccostomus*
*Solomys*
*Stenocephalemys*
*Stochomys*
*Thallomys*
*Thamnomys*
*Tokudaia*
*Tryphomys*
*Uranomys*

*Laomys*
*Mesembriomys*
*Oenomys*
*Ammomys*
*Mylomys*
*Dasymys*
*Arvicanthis*
*Hadromys*
*Golunda*
*Pelomys*
*Lemniscomys*
*Rhabdomys*
*Hybomys*
*Millardia*
*Pyromys*
*Dacnomys*
*Eropeplus*
*Stenocephalemys*
*Aethomys*
*Thallomys*
*Rattus*
*Maxomys*
*Hylomyscus*
*Mastomys*
*Praomys*
*Myomys*
*Stochomys*
*Tokudaia*
*Nilopegamys*
*Tryphomys*
*Gyomys*
*Leporillus*
*Pseudomys*
*Apomys*
*Melomys*
*Solomys*
*Pogonomelomys*
*Xenuromys*
*Uromys*
*Coelomys*
*Malacomys*
*Haeromys*
*Chiromyscus*
*Zelotomys*
*Diomys*
*Muriculus*
*Mus*
*Mycteromys*
*Leggadina*
*Colomys*
*Nesoromys*
*Crunomys*
*Macruromys*
*Lorentzimys*
*Lophuromys*
*Leimacomys*
*Notomys*
*Mastacomys*
*Echiothrix*
*Melasmothrix*
*Acomys*
*Uranomys*

*Uromys*
*Vandeleuria*
*Vernaya*
*Xenuromys*
*Zelotomys*
*Zyzomys*
SF. Dendromurinae
G. *Deanymys*
*Dendromus*
*Deomys*
*Malcothrix*
*Petromyscus*
*Prionomys*
*Steatomys*
SF. Otomyinae
G. *Myotomys*
*Otomys*
*Parotomys*
SF. Phloeomyinae
G. *Chiropodomys*
*Crateromys*
*Lenomys*
*Mallomys*
*Papagomys*
*Phloeomys*
*Pogonomys*
SF. Rhynchomyinae
G. *Rhynchomys*
SF. Hydromyinae
G. *Baiyankamys*
*Celaenomys*
*Chrotomys*
*Crossomys*
*Hydromys*
*Leptomys*
*Mayermys*
*Microhydromys*
*Neohydromys*
*Parahydromys*
*Paraleptomys*
*Pseudohydromys*
*Xeromys*
F. Gliridae
SF. Glirinae
G. *Dryomys*
*Eliomys*
*Glirulus*
*Glis*
*Muscardinus*
*Myomimus*
SF. Graphiurinae
G. *Graphiurus*
F. Platacanthomyidae
G. *Platacanthomys*
*Typhlomys*
F. Seleveniidae
G. *Selevinia*
F. Zapodidae
SF. Sicistinae
G. *Sicista*
SF. Zapodinae
G. *Eozapus*

*Bandicota*
*Nesokia*
*Beamys*
*Saccostomus*
*Cricetomys*
*Anisomys*
SF. Dendromurinae
G. *Dendromus*
*Malcothrix*
*Prionomys*
*Petromyscus*
*Delanymys*
*Steatomys*
*Deomys*
SF. Otomyinae
G. *Otomys*
*Myotomys*
*Parotomys*
SF. Phloeomyinae
G. *Lenomys*
*Pogonomys*
*Chiropodomys*
*Mallomys*
*Papagomys*
*Phloeomys*
*Crateromys*
SF. Rhynchomyinae
G. *Rhynchomys*
SF. Hydromyinae
G. *Chrotomys*
*Celaenomys*
*Crossomys*
*Xeromys*
*Hydromys*
*Parahydromys*
*Neohydromys*
*Leptomys*
*Microhydromys*
*Paraleptomys*
*Baiyankamys*
*Pseudohydromys*
*Mayermys*
F. Gliridae
SF. Glirinae
G. *Glis*
*Muscardinus*
*Eliomys*
*Dryomys*
*Glirulus*
*Myomimus*
SF. Graphiurinae
G. *Graphiurus*
F. Platacanthomyidae
G. *Platacanthomys*
*Typhlomys*
F. Seleviniidae
G. *Selevinia*
F. Zapodidae
SF. Sicistinae
G. *Sicista*
SF. Zapodinae
G. *Zapus*

*Napaeozapus*
*Zapus*
F. Dipodidae
SF. Dipodinae
G. *Alactagulus*
*Allactaga*
*Dipus*
*Eremodipus*
*Jaculus*
*Paradipus*
*Pygeretmus*
*Scarturus*
*Scirtopoda*
*Stylodipus*
SF. Cardiocraniinae
G. *Cardiocranius*
*Salpingotus*
SF. Euchoreutinae
G. *Euchoreutes*
F. Hystricidae
SF. Hystricinae
G. *Acanthion*
*Hystrix*
*Thecurus*
SF. Atherurinae
G. *Atherurus*
*Trichys*
F. Erethizontidae
SF. Erethizontinae
G. *Coendou*
*Echinoprocta*
*Erethizon*
SF. Chaetomyinae
G. *Chaetomys*
F. Caviidae
SF. Caviinae
G. *Cavia*
*Galea*
*Kerodon*
*Microcavia*
SF. Dolichotinae
G. *Dolichotis*
F. Hydrochoeridae
SF. Hydrochoerinae
G. *Hydrochoerus*
F. Dinomyidae
G. *Dinomys*
F. Dasyproctidae
SF. Cuniculinae
G. *Cuniculus (=Agouti)*
*Stictomys*
SF. Dasyproctinae
G. *Dasyprocta*
*Myoprocta*
F. Chinchillidae
G. *Chinchilla*
*Lagidium*
*Lagostomus*
F. Capromyidae
G. *Capromys*
*Geocapromys*
*Myocastor*

*Eozapus*
*Napaeozapus*
F. Dipodidae
SF. Dipodinae
G. *Dipus*
*Paradipus*
*Eremodipus*
*Jaculus*
*Scirtopoda*
*Stylodipus*
*Scarturus*
*Allactaga*
*Alactagulus*
*Pygeretmus*
SF. Cardiocraniinae
G. *Cardiocranius*
*Salpingotus*
SF. Euchoreutinae
G. *Euchoreutes*
F. Hystricidae
SF. Hystricinae
G. *Acanthion*
*Thecurus*
*Hystrix*
SF. Atherurinae
G. *Atherurus*
*Trichys*
F. Erethizontidae
SF. Erethizontinae
G. *Erethizon*
*Coendou*
*Echinoprocta*
SF. Chaetomyinae
G. *Chaetomys*
F. Caviidae
SF. Caviinae
G. *Cavia*
*Kerodon*
*Galea*
*Microcavia*
SF. Dolichotinae
G. *Dolichotis*
F. Hydrochoeridae
SF. Hydrochoerinae
G. *Hydrochoerus*
F. Dinomyidae
G. *Dinomys*
F. Dasyproctidae
SF. Cuniculinae
G. *Cuniculus (=Agouti)*
*Stictomys*
SF. Dasyproctinae
G. *Dasyprocta*
*Myoprocta*
F. Chinchillidae
G. *Lagostomus*
*Lagidium*
*Chinchilla*
F. Capromyidae
G. *Capromys*
*Geocapromys*
*Procapromys*

- *Plagiodontia*
- *Procapromys*
- F. Octodontidae
  - G. *Aconaemys*
  - *Octodon*
  - *Octodontomys*
  - *Octomys*
  - *Spalacopus*
- F. Ctenomyidae
  - G. *Ctenomys*
- F. Abrocomidae
  - G. *Abrocoma*
- F. Echimyidae
  - SF. Echimyinae
    - G. *Carterodon*
    - *Cercomys*
    - *Clyomys*
    - *Diplomys*
    - *Echimys*
    - *Euryzygomatomys*
    - *Hoplomys*
    - *Isothrix*
    - *Loncothrix*
    - *Mesomys*
    - *Proechimys*
  - SF. Dactylomyinae
    - G. *Dactylomys*
    - *Kannabateomys*
    - *Lachnomys*
    - *Thrinacodus*
- F. Thryonomyidae
  - G. *Thryonomys*
- F. Petromyidae
  - G. *Petromus*
- F. Bathyergidae
  - G. *Bathyergus*
  - *Cryptomys*
  - *Georychus*
  - *Heliophobius*
  - *Heterocephalus*
- F. Ctenodactylidae
  - G. *Ctenodactylus*
  - *Felovia*
  - *Massoutiera*
  - *Pectinator*

Order CETACEA

- F. Platanistidae
  - SF. Platanistinae
    - G. *Platanista*
  - SF. Iniinae
    - G. *Inia*
    - *Lipotes*
  - SF. Stenodelphininae
    - G. *Stenodelphis*
- F. Ziphiidae
  - G. *Berardius*
  - *Hyperoodon*
  - *Mesoplodon*
  - *Tasmacetus*
  - *Ziphius*
- F. Physeteridae
  - SF. Physeterinae

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- *Plagiodontia*
- *Myocastor*
- F. Octodontidae
  - G. *Octodon*
  - *Octodontomys*
  - *Spalacopus*
  - *Aconaemys*
  - *Octomys*
- F. Ctenomyidae
  - G. *Ctenomys*
- F. Abrocomidae
  - G. *Abrocoma*
- F. Echimyidae
  - SF. Echimyinae
    - G. *Proechimys*
    - *Hoplomys*
    - *Euryzygomatomys*
    - *Clyomys*
    - *Carterodon*
    - *Cercomys*
    - *Mesomys*
    - *Lonchothrix*
    - *Isothrix*
    - *Diplomys*
    - *Echimys*
  - SF. Dactylomyinae
    - G. *Dactylomys*
    - *Kannabateomys*
    - *Lachnomys*
    - *Thrinacodus*
- F. Thryonomyidae
  - G. *Thryonomys*
- F. Petromyidae
  - G. *Petromus*
- F. Bathyergidae
  - G. *Georychus*
  - *Cryptomys*
  - *Heliophobius*
  - *Bathyergus*
  - *Heterocephalus*
- F. Ctenodactylidae
  - G. *Ctenodactylus*
  - *Pectinator*
  - *Massoutiera*
  - *Felovia*

Order CETACEA

- F. Platanistidae
  - SF. Platanistinae
    - G. *Platanista*
  - SF. Iniinae
    - G. *Inia*
    - *Lipotes*
  - SF. Stenodelphininae
    - G. *Stenodelphis*
- F. Ziphiidae
  - G. *Mesoplodon*
  - *Ziphius*
  - *Tasmacetus*
  - *Berardius*
  - *Hyperoodon*
- F. Physeteridae
  - SF. Physeterinae

G. *Physeter*
SF. Kogiinae
G. *Kogia*
F. Monodontidae
G. *Delphinapterus*
*Monodon*
F. Delphinidae
G. *Cephalarhynchus*
*Delphinus*
*Feresa*
*Globicephala*
*Grampus*
*Lagenodelphis*
*Lagenorhynchus*
*Lissodelphis*
*Orcaella*
*Orcinus*
*Prodelphinus*
*Pseudorca*
*Sotalia*
*Sousa*
*Stenella*
*Steno*
*Tursiops*
F. Phocaenidae
G. *Neomeris*
*Phocaena*
*Phocaenoides*
F. Eschrichtiidae
G. *Eschrichtius*
F. Balaenopteridae
G. *Balaenoptera*
*Megaptera*
*Sibbaldus*
F. Balaenidae
G. *Balaena*
*Eubalaena*
*Neobalaena*
Order CARNIVORA
F. Canidae
SF. Caninae
G. *Alopex*
*Atelocynus*
*Canis*
*Cerdocyon*
*Chrysocyon*
*Dusicyon*
*Fennecus*
*Nyctereutes*
*Urocyon*
*Vulpes*
SF. Simocyoninae
G. *Cuon*
*Lycaon*
*Speothos*
SF. Octocyoninae
G. *Otocyon*
F. Ursidae
G. *Ailuropoda*
*Euarctos*
*Helarctos*
*Melursus*

G. *Physeter*
SF. Kogiinae
G. *Kogia*
F. Monodontidae
G. *Delphinapterus*
*Monodon*
F. Delphinidae
G. *Steno*
*Sousa*
*Sotalia*
*Stenella*
*Prodelphinus*
*Delphinus*
*Grampus*
*Tursiops*
*Lagenorhynchus*
*Feresa*
*Cephalorhynchus*
*Orcinus*
*Pseudorca*
*Orcaella*
*Globicephala*
*Lissodelphis*
*Lagenodelphis*
F. Phocaenidae
G. *Phocaena*
*Phocaenoides*
*Neomeris*
F. Eschrichtiidae
G. *Eschrichtius*
F. Balaenopteridae
G. *Balaenoptera*
*Megaptera*
*Sibbaldus*
F. Balaenidae
G. *Balaena*
*Eubalaena*
*Neobalaena*
Order CARNIVORA
F. Canidae
SF. Caninae
G. *Canis*
*Alopex*
*Vulpes*
*Fennecus*
*Urocyon*
*Nyctereutes*
*Dusicyon*
*Cerdocyon*
*Atelocynus*
*Chrysocyon*
SF. Simocyoninae
G. *Speothos*
*Cuon*
*Lycaon*
SF. Otocyoninae
G. *Otocyon*
F. Ursidae
G. *Tremarctos*
*Selenarctos*
*Ursus*
*Euarctos*

*Selenarctos*
*Thalarctos*
*Tremarctos*
*Ursus*
F. Procyonidae
SF. Procyoninae
G. *Bassaricyon*
*Bassariscus*
*Nasua*
*Nasuella*
*Potos*
*Procyon*
SF. Ailurinae
G. *Ailurus*
F. Mustelidae
SF. Mustelinae
G. *Charronia*
*Eira*
*Galera*
*Grison*
*Grisonella*
*Gulo*
*Lyncodon*
*Martes*
*Mustela*
*Poecilictis*
*Poecilogale*
*Vormela*
*Zorilla*
SF. Mellivorinae
G. *Mellivora*
SF. Melinae
G. *Arctonyx*
*Helictis*
*Meles*
*Melogale*
*Mydaus*
*Suillotaxus*
*Taxidea*
SF. Mephitinae
G. *Conepatus*
*Mephitis*
*Spilogale*
SF. Lutrinae
G. *Amblonyx*
*Aonyx*
*Enhydra*
*Lontra*
*Lutra*
*Paraonyx*
*Pteronura*
F. Viverridae
SF. Viverrinae
G. *Civettictis*
*Genetta*
*Osbornictis*
*Pardictis*
*Poiana*
*Prionodon*
*Viverra*
*Viverricula*
SF. Paradoxurinae
G. *Arctictis*

*Thalarctos*
*Helarctos*
*Melursus*
*Ailuropoda*
F. Procyonidae
SF. Procyoninae
G. *Bassariscus*
*Procyon*
*Nasua*
*Nasuella*
*Potos*
*Bassaricyon*
SF. Ailurinae
G. *Ailurus*
F. Mustelidae
SF. Mustelinae
G. *Mustela*
*Vormela*
*Martes*
*Charronia*
*Galera*
*Eira*
*Grison*
*Grisonella*
*Lyncodon*
*Zorilla*
*Poecilictis*
*Poecilogale*
*Gulo*
SF. Mellivorinae
G. *Mellivora*
SF. Melinae
G. *Meles*
*Arctonyx*
*Mydaus*
*Suillotaxus*
*Taxidea*
*Helictis*
*Melogale*
SF. Mephitinae
G. *Mephitis*
*Spilogale*
*Conepatus*
SF. Lutrinae
G. *Lutra*
*Lontra*
*Lutrogale*
*Pteronura*
*Amblonyx*
*Paraonyx*
*Enhydra*
F. Viverridae
SF. Viverrinae
G. *Poiana*
*Genetta*
*Viverricula*
*Osbornictis*
*Viverra*
*Civettictis*
*Prionodon*
*Pardictis*
SF. Paradoxurinae
G. *Nandinia*

*Arctogalidia*
*Marcogalidia*
*Nandinia*
*Paguma*
*Paradoxurus*
SF. Hemigalinae
G. *Chrotogale*
*Cynogale*
*Diplogale*
*Eupleres*
*Fossa*
*Galidia*
*Galidictis*
*Hemigalus*
*Mungotictis*
*Salanoia*
SF. Herpestinae
G. *Atilax*
*Bdeogale*
*Crossarchus*
*Cynictis*
*Dologale*
*Helogale*
*Herpestes*
*Ichneumia*
*Liberiicitis*
*Mungos*
*Paracynictis*
*Rhynchogale*
*Suricata*
*Xenogale*
SF. Cryptoproctinae
G. *Cryptoprocta*
F. Hyaenidae
SF. Protelinae
G. *Proteles*
SF. Hyaeninae
G. *Crocuta*
*Hyaena*
F. Felidae
SF. Felinae
G. *Acinonyx*
*Felis*
*Lynx*
*Neofelis*
*Panthrera*
*Uncia*
Order PINNIPEDIA
F. Otariidae
G. *Arctocephalus*
*Callorhinus*
*Eumetopias*
*Neophoca*
*Otaria*
*Zalophus*
F. Odobenidae
G. *Odobenus*
F. Phocidae
SF. Phocinae
G. *Erignathus*
*Halichoerus*
*Histriophoca*

*Arctogalidia*
*Paradoxurus*
*Paguma*
*Macrogalidia*
*Arctictis*
SF. Hemigalinae
G. *Fossa*
*Hemigalus*
*Chrotogale*
*Diplogale*
*Cynogale*
*Eupleres*
*Galidia*
*Galidictis*
*Mungotictis*
*Salanoia*
SF. Herpestinae
G. *Suricata*
*Herpestes*
*Helogale*
*Dologale*
*Atilax*
*Mungos*
*Crossarchus*
*Liberiicitis*
*Ichneumia*
*Bdeogale*
*Rhynchogale*
*Cynictis*
*Paracynictis*
*Xenogale*
SF. Cryptoproctinae
G. *Cryptoprocta*
F. Hyaenidae
SF. Protelinae
G. *Proteles*
SF. Hyaeninae
G. *Crocuta*
*Hyaena*
F. Felidae
SF. Felinae
G. *Felis*
*Lynx*
*Panthera*
*Neofelis*
*Uncia*
*Acinonyx*
Order PINNIPEDIA
F. Otariidae
G. *Arctocephalus*
*Callorhinus*
*Zalophus*
*Neophoca*
*Eumetopias*
*Otaria*
F. Odobenidae
G. *Odobenus*
F. Phocidae
SF. Phocinae
G. *Phoca*
*Pusa*
*Histriophoca*

*Pagophilus*
*Phoca*
*Pusa*
SF. Lobodontinae
G. *Hydrurga*
*Leptonychotes*
*Lobodon*
*Ommatophoca*
SF. Monachinae
G. *Monachus*
SF. Cystophorinae
G. *Cystophora*
*Mirounga*
Order TUBULIDENTATA
F. Orycteropodidae
G. *Orycteropus*
Order PROBOSCIDEA
F. Elephantidae
SF. Elephantinae
G. *Elephas*
*Loxodonta*
Order HYRACOIDEA
F. Procaviidae
G. *Dendrohyrax*
*Heterohyrax*
*Procavia*
Order SIRENIA
F. Dugongidae
SF. Dugonginae
G. *Dugong*
F. Trichechidae
G. *Trichechus*
Order PERISSODACTYLA
F. Equidae
SF. Equinae
G. *Equus*
F. Tapiridae
G. *Tapirus*
F. Rhinocerotidae
SF. Rhinocerotinae
G. *Rhinoceros*
SF. Dicerorhininae
G. *Ceratotherium*
*Dicerorhinus*
*Diceros*
Order ARTIODACTYLA
F. Suidae
SF. Suinae
G. *Babirussa*
*Hylochoerus*
*Phacochoerus*
*Potamochoerus*
*Sus*
F. Tayassuidae
SF. Tayassuinae
G. *Dicotyles*
*Tayassu*
F. Hippopotamidae
G. *Choeropsis*
*Hippopotamus*
F. Camelidae
SF. Camelinae

*Pagophilus*
*Halichoerus*
*Erignathus*
SF. Lobodontinae
G. *Lobodon*
*Ommatophoca*
*Hydrurga*
*Leptonychotes*
SF. Monachinae
G. *Monachus*
SF. Cystophorinae
G. *Cystophora*
*Mirounga*
Order TUBULIDENTATA
F. Orycteropodidae
G. *Orycteropus*
Order PROBOSCIDEA
F. Elephantidae
SF. Elephantinae
G. *Loxodonta*
*Elephas*
Order HYRACOIDEA
F. Procaviidae
G. *Dendrohyrax*
*Heterohyrax*
*Procavia*
Order SIRENIA
F. Dugongidae
SF. Dugonginae
G. *Dugong*
F. Trichechidae
G. *Trichechus*
Order PERISSODACTYLA
F. Equidae
SF. Equinae
G. *Equus*
F. Tapiridae
G. *Tapirus*
F. Rhinocerotidae
SF. Rhinocerotinae
G. *Rhinoceros*
SF. Dicerorhininae
G. *Dicerorhinus*
*Ceratotherium*
*Diceros*
Order ARTIODACTYLA
F. Suidae
SF. Suinae
G. *Potamochoerus*
*Sus*
*Phacochoerus*
*Hylochoerus*
*Babirussa*
F. Tayassuidae
SF. Tayassuinae
G. *Tayassu*
*Dicotyles*
F. Hippopotamidae
G. *Hippopotamus*
*Choeropsis*
F. Camelidae
SF. Camelinae

G. *Camelus*
*Lama*
*Vicugna*
F. Tragulidae
G. *Hyemoschus*
*Tragulus*
F. Cervidae
SF. Moschinae
G. *Moschus*
SF. Muntiacinae
G. *Elaphodus*
*Muntiacus*
SF. Cervinae
G. *Axis*
*Cervus*
*Dama*
*Elaphurus*
SF. Odocoileinae
G. *Alces*
*Blastoceros*
*Blastocerus*
*Capreolus*
*Hippocamelus*
*Hydropotes*
*Mazama*
*Odocoileus*
*Ozotoceras*
*Pudu*
*Rangifer*
F. Giraffidae
SF. Palaeotraginae
G. *Okapia*
SF. Giraffinae
G. *Giraffa*
F. Antilocapridae
SF. Antilocaprinae
G. *Antilocapra*
F. Bovidae
SF. Bovinae
G. *Anoa*
*Bibos*
*Bison*
*Boocercus*
*Bos*
*Boselaphus*
*Bubalus*
*Strepsiceros*
*Syncerus*
*Taurotragus*
*Tetracerus*
*Tragelaphus*
SF. Cephalophinae
G. *Cephalophus*
*Philantomba*
*Sylvicapra*
SF. Hippotraginae
G. *Addax*
*Adenota*
*Alcelaphus*
*Beatragus*
*Connochaetes*
*Damaliscus*
*Gorgon*

G. *Lama*
*Vicugna*
*Camelus*
F. Tragulidae
G. *Hyemoschus*
*Tragulus*
F. Cervidae
SF. Moschinae
G. *Moschus*
SF. Muntiacinae
G. *Muntiacus*
*Elephodus*
SF. Cervinae
G. *Dama*
*Axis*
*Cervus*
*Elaphurus*
SF. Odocoileinae
G. *Odocoileus*
*Mazama*
*Hippocamelus*
*Blastocerus*
*Blastoceros*
*Ozotoceras*
*Pudu*
*Alces*
*Rangifer*
*Hydropotes*
*Capreolus*
F. Giraffidae
SF. Palaeotraginae
G. *Okapia*
SF. Giraffinae
G. *Giraffa*
F. Antilocapridae
SF. Antilocaprinae
G. *Antilocapra*
F. Bovidae
SF. Bovinae
G. *Strepsiceros*
*Tragelaphus*
*Taurotragus*
*Boocercus*
*Boselaphus*
*Tetracerus*
*Bubalus*
*Anoa*
*Bos*
*Bibos*
*Syncerus*
*Bison*
SF. Cephalophinae
G. *Cephalophus*
*Philantomba*
*Sylvicapra*
SF. Hippotraginae
G. *Kobus*
*Adenota*
*Onotragus*
*Redunca*
*Pelea*
*Hippotragus*
*Oryx*

*Hippotragus*
*Kobus*
*Onotragus*
*Oryx*
*Pelea*
*Redunca*
SF. Antilopinae
G. *Aepyceros*
*Ammodorcas*
*Antidorcas*
*Antilope*
*Dorcatragus*
*Gazella*
*Litocranius*
*Madoqua*
*Neotragus*
*Nesotragus*
*Oreotragus*
*Ourebia*
*Procapra*
*Raphicerus*
*Rhynchotragus*
SF. Caprinae
G. *Ammotragus*
*Budorcas*
*Capra*
*Capricornis*
*Hemitragus*
*Naemorhedus*
*Oreamnos*
*Ovibos*
*Ovis*
*Pantholops*
*Pseudois*
*Rupicapra*
*Saiga*

*Addax*
*Damaliscus*
*Alcelaphus*
*Beatragus*
*Connochaetes*
*Gorgon*
SF. Antilopinae
G. *Oreotragus*
*Ourebia*
*Raphicerus*
*Nesotragus*
*Neotragus*
*Madoqua*
*Rhynchotragus*
*Dorcatragus*
*Antilope*
*Aepyceros*
*Ammodorcas*
*Litocranius*
*Gazella*
*Antidorcas*
*Procapra*
SF. Caprinae
G. *Pantholops*
*Saiga*
*Naemorhedus*
*Capricornis*
*Oreamnos*
*Rupicapra*
*Budorcas*
*Ovibos*
*Hemitragus*
*Capra*
*Pseudois*
*Ammotragus*
*Ovis*

APPENDIX B. — Unmodified phylogenetic arrangements of North American Recent mammals as used by Miller (1924), Miller and Kellogg (1955), and Hall and Kelson (1959).

| Miller, 1924 | Miller and Kellogg, 1955 | Hall and Kelson, 1959 |
|---|---|---|
| CLASS MAMMALIA | CLASS MAMMALIA | CLASS MAMMALIA |
| Order MARSUPIALIA | Order MARSUPIALIA | Order MARSUPIALIA |
| F. Didelphidae | F. Didelphidae | F. Didelphidae |
| G. *Didelphis* | G. *Didelphis* | G. *Didelphis* |
| *Marmosa* | *Marmosa* | *Chironectes* |
| *Monodelphis* | *Monodelphis* | *Philander* |
| *Metachirops* | *Philander* | *Marmosa* |
| *Metachirus* | *Metachirus* | *Caluromys* |
| *Philander* | *Caluromys* | *Monodelphis* |
| *Chironectes* | *Chironectes* | *Metachirus* |
| Order INSECTIVORA | Order INSECTIVORA | Order INSECTIVORA |
| F. Nesophontidae | F. Solenodentidae | F. Solenodontidae |
| G. *Nesophontes* | G. *Solenodon* | G. *Solenodon* |
| F. Solenodontidae | *Atopogale* | *Atopogale* |
| G. *Solenodon* | F. Soricidae | F. Soricidae |
| F. Talpidae | SF. Soricinae | SF. Soricinae |
| SF. Scalopinae | G. *Sorex* | G. *Sorex* |
| G. *Scapanus* | *Microsorex* | *Microsorex* |
| *Parascalops* | *Blarina* | *Blarina* |
| *Scalopus* | *Cryptotis* | *Cryptotis* |
| SF. Uropsilinae | *Notiosorex* | *Notiosorex* |
| G. *Neurotrichus* | *Megasorex* | |
| SF. Condylurinae | F. Talpidae | F. Talpidae |
| G. *Condylura* | SF. Scalopinae | SF. Scalopinae |
| F. Soricidae | G. *Neurotrichus* | G. *Neurotrichus* |
| SF. Soricinae | *Scapanus* | *Scapanus* |
| G. *Sorex* | *Parascalops* | *Parascalops* |
| *Neosorex* | *Scalopus* | *Scalopus* |
| *Microsorex* | SF. Condylurinae | SF. Condylurinae |
| *Cryptotis* | G. *Condylura* | G. *Condylura* |
| *Blarina* | F. Nesophontidae | F. Nesophontidae |
| *Notiosorex* | G. *Nesophontes* | G. *Nesophontes* |
| Order CHIROPTERA | Order CHIROPTERA | Order CHIROPTERA |
| F. Emballonuridae | F. Emballonuridae | F. Emballonuridae |
| SF. Emballonurinae | SF. Emballonurinae | SF. Emballonurinae |
| G. *Rhynchonycteris* | G. *Rhynchonycteris* | G. *Rhynchonycteris* |
| *Saccopteryx* | *Saccopteryx* | *Saccopteryx* |
| *Cormura* | *Cormura* | *Cormura* |
| *Peropteryx* | *Peropteryx* | *Peropteryx* |
| *Centronycteris* | *Centronycteris* | *Centronycteris* |
| *Balantiopteryx* | *Balantiopteryx* | *Balantiopteryx* |
| SF. Diclidurinae | SF. Diclidurinae | SF. Diclidurinae |
| G. *Diclidurus* | G. *Diclidurus* | G. *Diclidurus* |
| F. Noctilionidae | F. Noctilionidae | F. Noctilionidae |
| G. *Noctilio* | G. *Noctilio* | G. *Noctilio* |
| *Diras* | | |
| F. Phyllostomatidae | F. Phyllostomatidae | F. Phyllostomatidae |
| SF. Chilonycterinae | SF. Chilonycterinae | SF. Chilonycterinae |
| G. *Chilonycteris* | G. *Chilonycteris* | G. *Chilonycteris* |
| *Pteronotus* | *Pteronotus* | *Pteronotus* |
| *Mormoops* | *Mormoops* | *Mormoops* |
| SF. Phyllostomatinae | SF. Phyllostomatinae | SF. Phyllostomatinae |
| G. *Micronycteris* | G. *Micronycteris* | G. *Micronycteris* |
| *Xenoctenes* | *Macrotus* | *Macrotus* |
| *Glyphonycteris* | *Lonchorhina* | *Lonchorhina* |
| *Macrotus* | *Macrophyllum* | *Macrophyllum* |
| *Lonchorhina* | *Tonatia* | *Tonatia* |

*Macrophyllum*
*Tonatia*
*Mimon*
*Phyllostomus*
*Trachops*
*Chrotopterus*
*Vampyrum*
SF. Glossophaginae
G. *Glossophaga*
*Lonchophylla*
*Monophyllus*
*Anoura*
*Choeronycteris*
*Hylonycteris*
*Leptonycteris*
*Lichonycteris*

SF. Carolliinae
G. *Carollia*
SF. Sturnirinae
G. *Sturnira*

SF. Stenoderminae
G. *Brachyphylla*
*Uroderma*
*Vampyrops*
*Vampyrodes*
*Vampyressa*
*Chiroderma*
*Ectophylla*
*Artibeus*
*Ardops*
*Phyllops*
*Ariteus*
*Stenoderma*
*Pygoderma*
*Centurio*

SF. Phyllonycterinae
G. *Phyllonycteris*
*Erophylla*
*Reithronycteris*
F. Desmodontidae
G. *Desmodus*
*Diphylla*
F. Natalidae
G. *Natalus*
*Chilonatalus*
*Nyctiellus*
F. Thyropteridae
G. *Thyroptera*
F. Vespertilionidae
SF. Vespertilioninae
G. *Myotis*
*Pizonyx*
*Lasionycteris*
*Pipistrellus*
*Eptesicus*
*Nycteris*
*Dasypterus*
*Nycticeius*
*Rhogeessa*

*Mimon*
*Phyllostomus*
*Phylloderma*
*Trachops*
*Chrotopterus*
*Vampyrum*

SF. Glossophaginae
G. *Glossophaga*
*Lonchophylla*
*Monophyllus*
*Anoura*
*Choeronycteris*
*Choeroniscus*
*Hylonycteris*
*Leptonycteris*
*Lichonycteris*
SF. Carolliinae
G. *Carollia*
SF. Sturnirinae
G. *Sturnira*
*Sturnirops*
SF. Stenoderminae
G. *Brachyphylla*
*Uroderma*
*Vampyrops*
*Vampyrodes*
*Vampyressa*
*Chiroderma*
*Ectophylla*
*Artibeus*
*Enchisthenes*
*Ardops*
*Phyllops*
*Ariteus*
*Stenoderma*
*Pygoderma*
*Centurio*
SF. Phyllonycterinae
G. *Erophylla*
*Phyllonycteris*
*Reithronycteris*
F. Desmodontidae
G. *Desmodus*
*Diphylla*
F. Natalidae
G. *Natalus*

F. Thyropteridae
G. *Thyroptera*
F. Vespertilionidae
SF. Vespertilioninae
G. *Myotis*
*Pizonyx*
*Lasionycteris*
*Pipistrellus*
*Eptesicus*
*Lasiurus*
*Dasypterus*
*Nycticeius*
*Rhogeessa*

*Mimon*
*Phyllostomus*
*Phylloderma*
*Trachops*
*Chrotopterus*
*Vampyrum*

SF. Glossophaginae
G. *Glossophaga*
*Lonchophylla*
*Monophyllus*
*Anoura*
*Choeronycteris*
*Choeroniscus*
*Hylonycteris*
*Leptonycteris*
*Lichonycteris*
SF. Carolliinae
G. *Carollia*
SF. Sturnirinae
G. *Sturnira*
*Sturnirops*
SF. Stenoderminae
G. *Brachyphylla*
*Uroderma*
*Platyrrhinus*
*Vampyrodes*
*Vampyressa*
*Chiroderma*
*Ectophylla*
*Artibeus*
*Enchisthenes*
*Ardops*
*Phyllops*
*Ariteus*
*Stenoderma*
*Pygoderma*
*Centurio*
SF. Phyllonycterinae
G. *Erophylla*
*Phyllonycteris*

F. Desmodontidae
G. *Desmodus*
*Diphylla*
F. Natalidae
G. *Natalus*

F. Thyropteridae
G. *Thyroptera*
F. Vespertillionidae
SF. Vespertilioninae
G. *Myotis*
*Pizonyx*
*Lasionycteris*
*Pipistrellus*
*Eptesicus*
*Lasiurus*
*Dasypterus*
*Nycticeius*
*Rhogeessa*

*Baeodon*
*Euderma*
*Corynorhinus*
*Idionycteris*
SF. Nyctophilinae
G. *Antrozous*
F. Molossidae
G. *Molossops*
*Tadarida*
*Mormopterus*
*Promops*
*Eumops*
*Molossus*
Order CARNIVORA
F. Ursidae
G. *Euarctos*
*Ursus*
*Thalarctos*
F. Procyonidae
G. *Procyon*
*Nasua*
*Bassaricyon*
*Potos*
F. Mustelidae
SF. Mustelinae
G. *Martes*
*Mustela*
SF. Guloniae
G. *Gulo*
SF. Lutrinae
G. *Lutra*
SF. Enhydrinae
G. *Enhydra*
SF. Tayrinae
G. *Tayra*
SF. Grisoninae
G. *Grison*
SF. Mephitinae
G. *Spilogale*
*Mephitis*
*Conepatus*
SF. Taxidiinae
G. *Taxidea*
F. Viverridae
SF. Mungotinae
G. *Mungos*
F. Canidae
SF. Caninae
G. *Vulpes*
*Urocyon*
*Alopex*
*Canis*
SF. Cuoninae
G. *Icticyon*
F. Felidae
G. *Felis*
*Lynx*
Order PINNIPEDIA
F. Otariidae
G. *Zalophus*
*Eumetopias*
*Callorhinus*

*Baeodon*
*Euderma*
*Corynorhinus*
*Idionycteris*
SF. Nyctophilinae
G. *Antrozous*
F. Molossidae
G. *Cynomops*
*Tadarida*
*Mormopterus*
*Promops*
*Eumops*
*Molossus*
Order PRIMATES
F. Cebidae
SF. Aotinae
G. *Aotus*
SF. Alouattinae
G. *Alouatta*
SF. Cebinae
G. *Cebus*
*Saimiri*
SF. Atelinae
G. *Ateles*
F. Callithricidae
G. *Marikina*
F. Cercopithecidae
SF. Cercopithecinae
G. *Cercopithecus*
F. Hominidae
G. *Homo*

Order EDENTATA
F. Megalonychidae
G. *Acratocnus*
*Parocnus*
F. Myrmecophagidae

*Baeodon*
*Euderma*
*Corynorhinus*
*Idionycteris*
SF. Nyctophilinae
G. *Antrozous*
F. Molossidae
G. *Cynomops*
*Tadarida*
*Mormopterus*
*Eumops*
*Promops*
*Molossus*
Order PRIMATES
F. Cebidae
SF. Aotinae
G. *Aotus*
SF. Alouattinae
G. *Alouatta*
SF. Cebinae
G. *Cebus*
*Saimiri*
SF. Atelinae
G. *Ateles*
F. Callithricidae
G. *Saguinus*
F. Cercopithecidae
SF. Ceropithecinae
G. *Cercopithecus*
F. Hominidae
G. *Homo*

Order EDENTATA
F. Megalonychidae
G. *Acratocnus*
*Parocnus*
F. Myrmecophagidae

*Arctocephalus*
F. Phocidae
G. *Phoca*
*Erignathus*
*Monachus*
*Halichoerus*
*Cystophora*
*Mirounga*

F. Odobenidae
G. *Odobenus*
Order PRIMATES
F. Callitrichidae
G. *Cedipomidas*
F. Alouattidae
G. *Alouatta*
F. Aotidae
G. *Aotus*
F. Cebidae
SF. Cebinae
G. *Cebus*
SF. Atelinae
G. *Ateles*
F. Saimiridae
G. *Saimiri*
F. Lasiopygidae
SF. Lasiopyginae
G. *Lasiopyga*
F. Hominidae
G. *Homo*
Order RODENTIA

F. Sciuridae
SF. Sciurinae
G. *Marmota*
*Otospermophilus*
*Callospermophilus*
*Citellus*
*Ammospermophilus*
*Cynomys*
*Eutamias*
*Tamias*
*Sciurus*
*Microsciurus*
*Syntheosciurus*
SF. Pteromyinae
G. *Glaucomys*
F. Geomyidae
SF. Geomyinae
G. *Thomomys*
*Geomys*
*Pappogeomys*
*Cratogeomys*
*Platygeomys*
*Orthogeomys*
*Hetergeomys*
*Macrogeomys*
*Zygogeomys*
F. Heteromyidae
G. *Heteromys*

G. *Myrmecophaga*
*Tamandua*
*Cyclopes*
F. Bradypodidae
G. *Bradypus*
*Choloepus*
F. Dasypodidae
SF. Cabassouinae
G. *Cabassous*
SF. Dasypodinae
G. *Dasypus*
Order LAGOMORPHA
F. Ochotonidae
G. *Ochotona*
F. Leporidae
SF. Palaeolaginae
G. *Romerolagus*
SF. Leporinae
G. *Lepus*
*Sylvilagus*

Order RODENTIA
F. Aplodontidae
G. *Aplodontia*
F. Sciuridae
SF. Sciurinae
G. *Marmota*
*Cynomys*
*Citellus*
*Tamias*
*Eutamias*
*Sciurus*
*Tamiasciurus*
*Microsciurus*
*Syntheosciurus*

SF. Pteromyinae
G. *Glaucomys*
F. Geomyidae
SF. Geomyinae
G. *Thomomys*
*Geomys*
*Pappogeomys*
*Cratogeomys*
*Orthogeomys*
*Heterogeomys*
*Macrogeomys*
*Zygogeomys*

F. Heteromyidae
SF. Perognathinae

G. *Myrmecophaga*
*Tamandua*
*Cyclopes*
F. Bradypodidae
G. *Bradypus*
*Choloepus*
F. Dasypodidae
SF. Dasypodinae
G. *Cabassous*
*Dasypus*

Order LAGOMORPHA
F. Ochotonidae
G. *Ochotona*
F. Leporidae
SF. Palaeolaginae
G. *Romerolagus*
SF. Leporinae
G. *Sylvilagus*
*Lepus*

Order RODENTIA
F. Aplodontidae
G. *Aplodontia*
F. Sciuridae
SF. Sciurinae
G. *Tamias*
*Eutamias*
*Marmota*
*Ammospermophilus*
*Spermophilus*
*Cynomys*
*Sciurus*
*Syntheosciurus*
*Microsciurus*
*Tamiasciurus*

SF. Pteromyinae
G. *Glaucomys*
F. Geomyidae
SF. Geomyinae
G. *Thomomys*
*Geomys*
*Zygogeomys*
*Orthogeomys*
*Heterogeomys*
*Macrogeomys*
*Pappogeomys*
*Cratogeomys*

F. Heteromyidae
SF. Perognathinae

| | | |
|---|---|---|
| *Liomys* | G. *Perognathus* | G. *Perognathus* |
| *Perognathus* | | *Microdipodops* |
| *Dipodomys* | SF. Dipodomyinae | SF. Dipodomyinae |
| *Microdipodops* | G. *Dipodomys* | G. *Dipodomys* |
| | *Microdipodops* | |
| | SF. Heteromyinae | SF. Heteromyinae |
| | G. *Heteromys* | G. *Liomys* |
| | *Liomys* | *Heteromys* |
| F. Castoridae | F. Castoridae | F. Castoridae |
| G. *Castor* | G. *Castor* | G. *Castor* |
| F. Cricetidae | F. Cricetidae | F. Cricetidae |
| SF. Cricetinae | SF. Cricetinae | SF. Cricetinae |
| G. *Onychomys* | G. *Oryzomys* | G. *Oryzomys* |
| *Reithrodontomys* | *Oecomys* | *Megalomys* |
| *Baiomys* | *Megalomys* | *Neacomys* |
| *Peromyscus* | *Neacomys* | *Nectomys* |
| *Oryzomys* | *Nectomys* | *Rhipidomys* |
| *Neacomys* | *Rhipidomys* | *Tylomys* |
| *Zygodontomys* | *Tylomys* | *Ototylomys* |
| *Megalomys* | *Ototylomys* | *Nyctomys* |
| *Tylomys* | *Nyctomys* | *Otonyctomys* |
| *Ototylomys* | *Otonyctomys* | *Reithrodontomys* |
| *Nectomys* | *Reithrodontomys* | *Peromyscus* |
| *Rheomys* | *Peromyscus* | *Baiomys* |
| *Nyctomys* | *Baiomys* | *Onychomys* |
| *Rhipidomys* | *Onychomys* | *Zygodontomys* |
| *Cecomys* | *Zygodontomys* | *Scotinomys* |
| *Sigmodon* | *Scotinomys* | *Sigmodon* |
| *Scotinomys* | *Sigmodon* | *Neotomodon* |
| *Neotomodon* | *Neotomodon* | *Neotoma* |
| *Nelsonia* | *Neotoma* | *Xenomys* |
| *Teanopus* | *Teanopus* | *Nelsonia* |
| *Neotoma* | *Nelsonia* | *Rheomys* |
| *Hodomys* | *Rheomys* | |
| *Xenomys* | *Xenomys* | |
| SF. Microtinae | SF. Microtinae | SF. Microtinae |
| G. *Synaptomys* | G. *Dicrostonyx* | G. *Clethrionomys* |
| *Lemmus* | *Synaptomys* | *Phenacomys* |
| *Dicrostonyx* | *Lemmus* | *Microtus* |
| *Phenacomys* | *Clethrionomys* | *Lagurus* |
| *Evotomys* | *Phenacomys* | *Neofiber* |
| *Microtus* | *Orthriomys* | *Ondatra* |
| *Lagurus* | *Herpetomys* | *Lemmus* |
| *Pitymys* | *Microtus* | *Synaptomys* |
| *Neofiber* | *Pedomys* | *Dicrostonyx* |
| *Ondatra* | *Pitymys* | |
| | *Lagurus* | |
| | *Neofiber* | |
| | *Ondatra* | |
| F. Muridae | F. Muridae | F. Muridae |
| SF. Murinae | | |
| G. *Rattus* | G. *Rattus* | G. *Rattus* |
| *Mus* | *Mus* | *Mus* |
| F. Aplodontidae | | |
| G. *Aplodontia* | | |
| F. Zapodidae | F. Zapodidae | F. Zapodidae |
| SF. Zapodinae | SF. Zapodinae | SF. Zapodinae |
| G. *Zapus* | G. *Zapus* | G. *Zapus* |
| *Napaeozapus* | *Napaeozapus* | *Napaeozapus* |
| F. Erethizontidae | F. Erethizontidae | F. Erethizontidae |
| G. *Erethizon* | G. *Erethizon* | G. *Erethizon* |
| *Coendou* | *Coendou* | *Coendou* |

F. Echimyidae
SF. Echimyinae
G. *Hoplomys*
*Proechimys*
*Echimys*
*Diplomys*
*Brotomys*
*Boromys*
*Capromys*
*Plagiodontia*
*Isolobodon*

F. Dasyproctidae
G. *Dasyprocta*
F. Cuniculidae
G. *Cuniculus*
F. Hydrochaeridae
G. *Hydrochaerus*

Order LAGOMORPHA
F. Ochotonidae
G. *Ochotona*
F. Leporidae
G. *Lepus*
*Sylvilagus*
*Brachylagus*
*Romerolagus*

F. Hydrochaeridae
SF. Hydrochaerinae
G. *Hydrochaeris*
F. Heptaxodontidae
SF. Heptaxodontinae
G. *Heptaxodon*
*Elasmodontomys*
*Quemisia*
F. Dasyproctidae
SF. Cuniculinae
G. *Cuniculus*
SF. Dasyproctinae
G. *Dasyprocta*
F. Capromyidae
SF. Capromyinae
G. *Capromys*
*Geocapromys*
*Hexolobodon*
SF. Plagiodontinae
G. *Plagiodontia*
*Isolobodon*
*Aphaetreus*
SF. Myocastorinae
G. *Myocastor*
F. Echimyidae
SF. Echimyinae
G. *Hoplomys*
*Proechimys*
*Echimys*
*Diplomys*
*Heteropsomys*
*Homopsomys*
*Brotomys*
*Boromys*
Order CETACEA
F. Ziphiidae
G. *Berardius*
*Mesoplodon*
*Ziphius*
*Hyperoodon*
F. Physeteridae
G. *Physeter*
F. Kogiidae
G. *Kogia*
F. Monodontidae
SF. Delphinapterinae
G. *Delphinapterus*
SF. Monodontinae
G. *Monodon*
F. Delphinidae
SF. Delphininae
G. *Stenella*
*Steno*
*Delphinus*
*Tursiops*
*Lissodelphis*
*Lagenorhynchus*
*Grampus*
*Grampidelphis*
*Pseudorca*
*Globicephala*
*Phocoena*
*Phocoenoides*

F. Hydrochaeridae
SF. Hydrochaerinae
G. *Hydrochaeris*
F. Heptaxodontidae
SF. Heptaxodontinae
G. *Heptaxodon*
*Elasmodontomys*
*Quemisia*
F. Dasyproctidae
SF. Agoutinae
G. *Agouti*
SF. Dasyproctinae
G. *Dasyprocta*
F. Capromyidae
SF. Capromyinae
G. *Capromys*
*Geocapromys*
*Hexolobodon*
SF. Plagiodontinae
G. *Plagiodontia*
*Isolobodon*
*Aphaetreus*
SF. Myocastorinae
G. *Myocastor*
F. Echimyidae
SF. Echimyinae
G. *Hoplomys*
*Proechimys*
*Echimys*
*Diplomys*
*Heteropsomys*
*Homopsomys*
*Brotomys*
*Boromys*
Order CETACEA
F. Ziphiidae
G, *Berardius*
*Mesoplodon*
*Ziphius*
*Hyperoodon*
F. Physeteridae
G. *Physeter*
F. Kogiidae
G. *Kogia*
F. Monodontidae
SF. Delphinapterinae
G. *Delphinapterus*
SF. Monodontinae
G. *Monodon*
F. Delphinidae
SF. Delphininae
G. *Stenella*
*Steno*
*Delphinus*
*Tursiops*
*Lissodelphis*
*Lagenorhynchus*
*Grampus*
*Grampidelphis*
*Pseudorca*
*Globicephala*
*Feresa*
*Phocoena*

| | | |
|---|---|---|
| | F. Eschrichtidae | F. Eschrichtidae |
| | G. *Eschrichtius* | G. *Eschrichtius* |
| | F. Balaenopteridae | F. Balaenopteridae |
| | SF. Balaenopterinae | SF. Balaenopterinae |
| | G. *Balaenoptera* | G. *Balaenoptera* |
| | *Sibbaldus* | *Sibbaldus* |
| | SF. Megapterinae | SF. Megapterinae |
| | G. *Megaptera* | G. *Megaptera* |
| | F. Balaenidae | F. Balaenidae |
| | G. *Eubalaena* | G. *Eubalaena* |
| | *Balaena* | *Balaena* |
| Order ARTIODACTYLA | Order CARNIVORA | Order CARNIVORA |
| F. Tayassuidae | F. Canidae | F. Canidae |
| G. *Pecari* | SF. Caninae | SF. Caninae |
| *Tayassu* | G. *Canis* | G. *Canis* |
| F. Cervidae | *Alopex* | *Alopex* |
| SF. Cervinae | *Vulpes* | *Vulpes* |
| G. *Cervus* | *Urocyon* | *Urocyon* |
| *Odocoileus* | SF. Simocyoninae | SF. Simocyoninae |
| *Mazama* | G. *Icticyon* | G. *Speothos* |
| *Alces* | F. Ursidae | F. Ursidae |
| *Rangifer* | G. *Euarctos* | G. *Ursus* |
| F. Antilocapridae | *Ursus* | *Thalarctos* |
| G. *Antilocapra* | *Thalarctos* | |
| F. Bovidae | F. Procyonidae | F. Procyonidae |
| G. *Bison* | SF. Procyoninae | SF. Procyoninae |
| *Ovibos* | G. *Bassariscus* | G. *Bassariscus* |
| *Ovis* | *Jentinkia* | *Procyon* |
| *Oreamnos* | *Procyon* | *Nasua* |
| | *Nasua* | *Potos* |
| | *Potos* | *Bassaricyon* |
| | *Bassaricyon* | |
| | F. Mustelidae | F. Mustelidae |
| | SF. Mustelinae | SF. Mustelinae |
| | G. *Martes* | G. *Martes* |
| | *Mustela* | *Mustela* |
| | SF. Tayrinae | SF. Tayrinae |
| | G. *Tayra* | G. *Eira* |
| | SF. Grisoninae | SF. Grisoninae |
| | G. *Grison* | G. *Galictis* |
| | SF. Guloninae | SF. Guloninae |
| | G. *Gulo* | G. *Gulo* |
| | SF. Taxidiinae | SF. Taxidiinae |
| | G. *Taxidea* | G. *Taxidea* |
| | SF. Mephitinae | SF. Mephitinae |
| | G. *Spilogale* | G. *Spilogale* |
| | *Mephitis* | *Mephitis* |
| | *Conepatus* | *Conepatus* |
| | SF. Lutrinae | SF. Lutrinae |
| | G. *Lutra* | G. *Lutra* |
| | SF. Enhydrinae | SF. Enhydrinae |
| | G. *Enhydra* | G. *Enhydra* |
| | F. Viverridae | F. Viverridae |
| | SF. Herpestinae | SF. Herpestinae |
| | G. *Herpestes* | G. *Herpestes* |
| | F. Felidae | F. Felidae |
| | G. *Felis* | G. *Felis* |
| | *Lynx* | *Lynx* |
| Order PERISSODACTYLA | Order PINNIPEDIA | Order PINNIPEDIA |
| F. Tapiridae | F. Otariidae | F. Otariidae |
| G. *Tapirella* | SF. Arctocephalinae | SF. Arctocephalinae |
| | G. *Callorhinus* | G. *Callorhinus* |
| | *Arctocephalus* | *Arctophoca* |
| | SF. Otariinae | SF. Otariinae |
| | G. *Eumetopias* | G. *Eumetopias* |
| | *Zalophus* | *Zalophus* |

Order XENARTHA
F. Bradypodidae
G. *Bradypus*
F. Choloepodidae
G. *Choloepus*
F. Myrmecophagidae
G. *Cyclopes*
*Tamandua*
*Myrmecophaga*
F. Dasypodidae
SF. Dasypodinae
G. *Dasypus*
SF. Cabassouinae
G. *Cabassous*
Order SIRENIA
F. Trichechidae
G. *Trichechus*
Order CETACEA
F. Balaenidae
G. *Eubalaena*
*Balaena*
F. Rhachianectidae
G. *Rhachianectes*
F. Blaenopteridae
SF. Balaenopterinae
G. *Balaenoptera*
*Sibbaldus*
SF. Megapterinae
G. *Megaptera*
F. Physeteridae
G. *Physeter*
F. Kogiidae
G. *Kogia*
F. Delphinidae
SF. Delphininae
G. *Prodelphinus*
*Steno*
*Delphinus*
*Tursiops*
*Lissodelphis*
*Lagenorhynchus*
*Orcinus*
*Grampus*
*Pseudorca*
*Globicephala*
*Phocaena*
*Phocoenoides*
SF. Delphinapterinae
G. *Delphinapterus*
SF. Monodontinae
G. *Monodon*
F. Ziphiidae
G. *Beraridus*
*Mesoplodon*
*Ziphius*
*Hyperoodon*

F. Odobenidae
G. *Odobenus*
F. Phocidae
SF. Phocinae
G. *Phoca*
*Erignathus*
*Halichoerus*
SF. Monachinae
G. *Monachus*
SF. Cystophorinae
G. *Cystophora*
*Mirounga*
Order SIRENIA
F. Trichechidae
G. *Trichechus*

Order PERISSODACTYLA
F. Tapiridae
G. *Tapirella*
Order ARTIODACTYLA
F. Tayassuidae
G. *Pecari*
*Tayassu*
F. Cervidae
SF. Cervinae
G. *Cervus*
SF. Odocoileinae
G. *Odocoileus*
*Mazama*
*Alces*
*Rangifer*
F. Antilocapridae
G. *Antilocapra*
F. Bovidae
SF. Bovinae
G. *Bison*
SF. Caprinae
G. *Oreamnos*
*Ovibos*
*Ovis*

F. Odobenidae
G. *Odobenus*
F. Phocidae
SF. Phocinae
G. *Phoca*
*Erignathus*
*Halichoerus*
SF. Monachinae
G. *Monachus*
SF. Cystophorinae
G. *Cystophora*
*Mirounga*
Order SIRENIA
F. Trichechidae
G. *Trichechus*

Order PERISSODACTYLA
F. Tapiridae
G. *Tapirus*
Order ARTIODACTYLA
F. Tayassuidae
G. *Tayassu*

F. Cervidae
SF. Cervinae
G. *Cervus*
SF. Odocoileinae
G. *Dama*
*Mazama*
*Alces*
*Rangifer*
F. Antilocapridae
G. *Antilocapra*
F. Bovidae
SF. Bovinae
G. *Bison*
SF. Caprinae
G. *Oreamnos*
*Ovibos*
*Ovis*

APPENDIX C. — Geographical arrangement of North American localities based on the system originating at the Museum of Vertebrate Zoology at Berkeley.

| Country | State | |
|---|---|---|
| Canada | 1. Northwest Territories | 7. Ontario |
| | 2. Yukon Territory | 8. Quebec |
| | 3. British Columbia | 9. Newfoundland - Labrador |
| | 4. Alberta | 10. New Brunswick |
| | 5. Saskatchewan | 11. Prince Edward Island |
| | 6. Manitoba | 12. Nova Scotia |
| Greenland | | |
| Iceland | | |
| United States | 1. Alaska | 26. Hawaii |
| | 2. Washington | 27. California |
| | 3. Montana | 28. Nevada |
| | 4. North Dakota | 29. Utah |
| | 5. South Dakota | 30. Colorado |
| | 6. Minnesota | 31. Kansas |
| | 7. Wisconsin | 32. Missouri |
| | 8. Michigan | 33. Kentucky |
| | 9. Maine | 34. West Virginia |
| | 10. New York | 35. Maryland |
| | 11. Vermont | 36. Delaware |
| | 12. New Hampshire | 37. Virginia |
| | 13. Massachusetts | 38. Arizona |
| | 14. Connecticut | 39. New Mexico |
| | 15. Rhode Island | 40. Oklahoma |
| | 16. Oregon | 41. Arkansas |
| | 17. Idaho | 42. Tennessee |
| | 18. Wyoming | 43. North Carolina |
| | 29. Nebraska | 44. Texas |
| | 20. Iowa | 45. Louisiana |
| | 21. Illinois | 46. Mississippi |
| | 22. Indiana | 47. Alabama |
| | 23. Ohio | 48. Georgia |
| | 24. Pennsylvania | 49. South Carolina |
| | 25. New Jersey | 50. Florida |
| Mexico | 1. Baja California | 17. Guanajuato |
| | 2. Sonora | 18. Queretaro |
| | 3. Chihuahua | 19. Hidalgo |
| | 4. Coahuila | 20. Colima |
| | 5. Nuevo Leon | 21. Michoacan |
| | 6. Tamaulipas | 22. Mexico |
| | 7. Sinaloa | 23. Mexico, Distrito Federal |
| | 8. Durango | 24. Tlaxcala |
| | 9. Zacatecas | 25. Puebla |
| | 10. San Luis Potosí | 26. Morelos |
| | 11. Nayarit | 27. Tabasco |
| | 12. Aguascalientes | 28. Campeche |
| | 13. Veracruz | 29. Guerrero |
| | 14. Yucatan | 30. Oaxaca |
| | 15. Quintana Roo | 31. Chiapas |
| | 16. Jalisco | |
| Cuba | | |
| Haiti | | |
| Dominican Republic | | |
| Jamaica | | |
| Puerto Rico | | |
| Belize | | |
| Guatemala | | |
| Honduras | | |
| El Salvador | | |
| Nicaragua | | |
| Costa Rica | | |
| Panama | | |

APPENDIX D. — Alphabetical arrangement of North American localities.

| Country | State | |
|---|---|---|
| Belize | | |
| Canada | 1. Alberta | 7. Nova Scotia |
| | 2. British Columbia | 8. Ontario |
| | 3. Manitoba | 9. Prince Edward Island |
| | 4. New Brunswick | 10. Quebec |
| | 5. Newfoundland-Labrador | 11. Saskatchewan |
| | 6. Northwest Territories | 12. Yukon Territory |
| Costa Rica | | |
| Cuba | | |
| Dominican Republic | | |
| El Salvador | | |
| Greenland | | |
| Guatemala | | |
| Haiti | | |
| Honduras | | |
| Iceland | | |
| Jamaica | | |
| Mexico | 1. Aguascalientes | 17. Nayarit |
| | 2. Baja California | 18. Nuevo Leon |
| | 3. Campeche | 19. Oaxaca |
| | 4. Chiapas | 20. Puebla |
| | 5. Chihuahua | 21. Queretaro |
| | 6. Coahuila | 22. Quintana Roo |
| | 7. Colima | 23. San Luis Potosi |
| | 8. Durango | 24. Sinaloa |
| | 9. Guanajuato | 25. Sonora |
| | 10. Guerrero | 26. Tabasco |
| | 11. Hidalgo | 27. Tamaulipas |
| | 12. Jalisco | 28. Tlaxcala |
| | 13. Mexico | 29. Veracruz |
| | 14. Mexico, Distrito Federal | 30. Yucatan |
| | 15. Michoacan | 31. Zacatecas |
| | 16. Morelos | |
| Nicaragua | | |
| Panama | | |
| Puerto Rico | | |
| United States | 1. Alabama | 26. Montana |
| | 2. Alaska | 27. Nebraska |
| | 3. Arizona | 28. Nevada |
| | 4. Arkansas | 29. New Hampshire |
| | 5. California | 30. New Jersey |
| | 6. Colorado | 31. New Mexico |
| | 7. Connecticut | 32. New York |
| | 8. Delaware | 33. North Carolina |
| | 9. Florida | 34. North Dakota |
| | 10. Georgia | 35. Ohio |
| | 11. Hawaii | 35. Oklahoma |
| | 12. Idaho | 36. Oregon |
| | 13. Illinois | 38. Pennsylvania |
| | 14. Indiana | 39. Rhode Island |
| | 15. Iowa | 40. South Carolina |
| | 16. Kansas | 41. South Dakota |
| | 17. Kentucky | 42. Tennessee |
| | 18. Louisiana | 43. Texas |
| | 19. Maine | 44. Utah |
| | 20. Maryland | 45. Vermont |
| | 21. Massachusetts | 46. Virginia |
| | 22. Michigan | 47. Washington |
| | 23. Minnesota | 48. West Virginia |
| | 24. Mississippi | 49. Wisconsin |
| | 25. Missouri | 50. Wyoming |

Comparis

| | | CORSAIR II | IRGMA | MARK IV |
|---|---|---|---|---|
| DEFINITION | SELF G Master | omputer Oriented eference System for utomatic Information etrieval | Information Retrieval Group of the Museum Association | None |
| WHEN DEVELOPED | | 1960's | 1967 | 1968 |
| WHERE DEVELOPED | Informat Division; Institutio D. C. | esearch Institute f Swedish National efense | Great Britain | Informatics Incorporated; Canoga Park, California |
| WHY DEVELOPED | General documen utilizatio | /ide range of ocumental services. | General data documentation and utilization. | Information retrieval; inventory control for business oriented data. |
| LANGUAGE USED | COBOL | nknown | Unknown | Non-procedural language |
| COMPUTER HARDWARE USED | 64 K me drives; 3 has been UNIVAC 1110, GE IBM 370 CDC 310 well 2015 | 3M 7090/1401; lexowriter 2301 | IBM 360 | IBM 360; OS, DOS, or TDOS operating systems. |
| MAJOR FUNCTIONS | Input; u nance; e writing; indexing; utility fu | nput; index production or name, place, nd subject; bject description. | Input; file merging; inventory; catalog output. | Input; updating; maintenance; editing; report writing; query; retrieval; indexing; utility functions. |
| COST | Free acq -$5000 f tation; u about 31 | nknown | Unknown | $70,000 or $40,000 (for non-profit organizations) for acquisition of program. |
| REMARKS | Widely u lections; modifica improver broadly a highly fle can inter other pro associate program remote te capabilit | imited utilization y other collections; oes not interact ith other programs. | Designed for efficient interaction with other programs. | Marketed through the Service Bureau Corporation; broadly applicable; highly flexible; can interact with other programs. |

APPENDIX E

Comparison chart, nine computerized information retrieval programs.

| | SELGEM | GRIPHOS | GIPSY | GIS |
|---|---|---|---|---|
| DEFINITION | SELF GEnerating Master | General Information Processor for Humanities-Oriented Studies | Generalized Information Processing System | Generalized Information System |
| WHEN DEVELOPED | 1970 | 1967 | 1968 | 1971 |
| WHERE DEVELOPED | Information Systems Division; Smithsonian Institution, Washington, D. C. | State University of New York; Stony Brook, New York | Research Institute and Merrick Computer Center; University of Oklahoma; Norman, Oklahoma | International Business Machines Corporation (IBM); White Plains, New York |
| WHY DEVELOPED | General collection documentation and utilization. | General collection documentation and utilization. | Ethnographic data documentation and utilization; has been used for biological collections. | General data documentation and utilization. |
| LANGUAGE USED | COBOL | PL/I and IBM 360/370 Assembler Language | IBM System/360 Assembler Language | IBM Assembler Language |
| COMPUTER HARDWARE USED | 64 K memory; 4 tape drives; 3 disk drives; has been used with UNIVAC 1106, UNIVAC 1110, GE 625, IBM 360, IBM 370, CDC 6400, CDC 3100 and Honeywell 2015. | 256 K memory; 2314 or 3330 disk drives, or IBM 360 or IBM 370 | 65 K memory; 2 IBM 2311 disk drives; IBM 360/40. | 256 K memory; 4 IBM 2311 disk drives; IBM 360/40 *or* IBM 360/50 with 512 K memory *or* IBM 370. |
| MAJOR FUNCTIONS | Input; updating; maintenance; editing; report writing; query; retrieval; indexing; utility functions. | Input; updating; maintenance; report writing; retrieval; interface. | Input; updating; maintenance; retrieval; query; utility functions. | Input; updating; maintenance; query; retrieval. |
| COST | Free acquisition; $500 -$5000 for implementation; utilization is about 31¢/record. | $1000 for annual subscription; additional operation costs. | $1400 for installation; monthly rental is $400-$550; monthly maintenance is $150. | Monthly rental is $450; additional cost for other features. |
| REMARKS | Widely used among collections; active modification and improvements; broadly applicable; highly flexible, can interact with other programs; associated assistance program (MESH); remote terminal capability. | Widely used among collections; active modification and improvements; broadly applicable; highly flexible; can interact with other programs; slow learning curve; no terminal capabilities. | Widely used among collections; broadly applicable; can interact with other programs; no future changes planned; remote terminal capability. | Limited ability to interact with other programs; entirely supported and controlled by IBM; remote terminal capabilities. |

| | ISIS | STIRS | CORSAIR II | IRGMA | MARK IV |
|---|---|---|---|---|---|
| DEFINITION | International Species Inventory System | Set Theoretic Information Retrieval System | Computer Oriented Reference System for Automatic Information Retrieval | Information Retrieval Group of the Museum Association | None |
| WHEN DEVELOPED | 1973 | 1965 | 1960's | 1967 | 1968 |
| WHERE DEVELOPED | Minnesota Zoological Garden; St. Paul, Minnesota. | Computing Center; University of Colorado; Boulder, Colorado | Research Institute of Swedish National Defense | Great Britain | Informatics Incorporated; Canoga Park, California |
| WHY DEVELOPED | Data documentation and utilization for zoo animals. | Taxonomic classification for systematic biology. | Wide range of documental services. | General data documentation and utilization. | Information retrieval; inventory control for business oriented data. |
| LANGUAGE USED | Unknown | FORTRAN and CDC Assembly Language | Unknown | Unknown | Non-procedural language |
| COMPUTER HARDWARE USED | IBM 370/158 | CDC 6400; KRONOS CDC disk | IBM 7090/1401; Flexowriter 2301 | IBM 360 | IBM 360; OS, DOS, or TDOS operating systems. |
| MAJOR FUNCTIONS | Input; query; retrieval; report writing. | Input; updating; query; retrieval; miscellaneous functions. | Input; index production for name, place, and subject; object description. | Input; file merging; inventory; catalog output. | Input; updating; maintenance; editing; report writing; query; retrieval; indexing; utility functions. |
| COST | $1.00/specimen each year; $15-$20 for annual reports. | Free acquisition; implementation and utilization costs are unknown. | Unknown | Unknown | $70,000 or $40,000 (for non-profit organizations) for acquisition of program. |
| REMARKS | Limited utilization by other collections; limited adaptability and flexibility; mostly or possibly entirely used by zoos. | Limited ability to interact with other programs; technical help limited. | Limited utilization by other collections; does not interact with other programs. | Designed for efficient interaction with other programs. | Marketed through the Service Bureau Corporation; broadly applicable; highly flexible; can interact with other programs. |